United States
CONSUMER PRODUCT SAFETY COMMISSION
Washington, D.C. 20207

CPSC/OFFICE OF THE SECRETARY
1998 NOV 20 A 9:12

VOTE SHEET

DATE: NOV 8 1998

TO : The Commission
Sadye E. Dunn, Secretary

FROM : Jeffrey Bromme, General Counsel
Stephen Lemberg, Assistant General Counsel

SUBJECT: Revisions to Laundering Requirements in Several FFA Standards; Proposed Rules

BALLOT VOTE DUE: 5 0

Attached is a staff briefing package recommending that the Commission issue proposed rules updating references to laundering requirements in Flammable Fabrics Act standards for sleepwear, mattresses and mattress pads, and rugs and carpets. Tab D of the package contains draft Federal Register notices.

Please indicate your vote on the following options.

I. Approve the Federal Register notices as drafted.

_____ _____
(Signature) (Date)

II. Approve the draft Federal Register notices with the following changes (please specify).

_____

_____

_____

_____ _____
(Signature) (Date)

NOTE: This document has not been reviewed or accepted by the Commission.
Initial rh **Date** 11/18/98

CPSA 6 (b)(1) Cleared
11/18/98
No Mfrs/PrvtLblrs or Products Identified
Excepted

III. Do not approve the draft Federal Register notices.

(Signature) _____ (Date) _____

IV. Take other action (please specify).

_____

_____

_____

(Signature) _____ (Date) _____

Attachment

BRIEFING PACKAGE

UPDATED STANDARD DETERGENT AND LAUNDERING PROCEDURE

FOR

FLAMMABLE FABRICS ACT STANDARDS

For Further Information Contact:
Margaret L. Neily, Project Manager
Directorate for Engineering Sciences
(301) 504-0508

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EXECUTIVE SUMMARY

In the early 1970's, when the Flammable Fabrics Act standards were developed, flame retardant (FR) treatments were commonly used to achieve the required performance of some sleepwear, carpets and rugs, and mattress pads. To ensure the durability of such treatments through their useful life, products are required to pass flammability tests before and after laundering or cleaning.

Five FFA standards incorporate the home laundering procedures in American Association of Textile Chemists and Colorists (AATCC) Test Method 124: "Appearance of Durable Press Fabric after Repeated Home Launderings" (1967, 1969 and 1982 versions). AATCC Test Method 124 specifies a standard phosphate-built reference detergent, laundering equipment, and washing/drying conditions. All of these specifications are outdated. Environmental concerns eliminated phosphate-based detergents to reduce pollution and led to energy-efficient laundering/drying equipment design and operation.

AATCC Test Method 124 was revised in 1996 to accommodate changes in detergent formulation, washing/drying equipment, and consumer practice. These changes were made with input from a number of AATCC and ASTM committees and a survey of actual consumer practice to better reflect what is currently on the market and used by consumers. Other existing and international standards reviewed for updating these home laundering procedures are also outdated or have other deficiencies.

CPSC staff evaluated the potential impact on current products of updating the laundering method to AATCC 124-1996. All known FR treated products were tested. No FR treated carpets and mattress pads were available. The staff compared flammability test results of complying sleepwear fabrics (with and without FR treatments) after laundering by the old and new AATCC methods. Only the Pyrovatex treated sleepwear was adversely affected by the new standard detergent. Other common powder detergents, but not liquids, had a similar effect. Pyrovatex was subsequently withdrawn from the sleepwear market (with one exception). The changes in washing machine and dryer operating conditions did not appear to make a difference in the flammability performance of any of the fabrics tested. Manufacturers and testing laboratories that serve the industry are already using the new AATCC 124-1996 procedures.

The staff recommends that the Commission update the FFA standards to reference AATCC 124-1996 with the current detergent, laundering procedures, and equipment and issue Notices of Proposed Rulemaking in the *Federal Register* for public comment. The draft Notices for each FFA standard update the references to applicable sections of AATCC 124-1996, "Appearance of Durable Press Fabric after Repeated Home Launderings" to better represent current consumer laundering practices. A 30 day effective date is also recommended.

United States
CONSUMER PRODUCT SAFETY COMMISSION
Washington, D.C. 20207

VOTE SHEET

DATE: NOV 18 1998

TO : The Commission
Sadye E. Dunn, Secretary

FROM : Jeffrey Bromme, General Counsel
Stephen Lemberg, Assistant General Counsel

SUBJECT: Revisions to Laundering Requirements in Several FFA Standards; Proposed Rules

BALLOT VOTE DUE: _____

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(Signature) (Date)

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III. Do not approve the draft Federal Register notices.

_____ _____

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IV. Take other action (please specify).

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Attachment

BRIEFING PACKAGE

UPDATED STANDARD DETERGENT AND LAUNDERING PROCEDURE

FOR

FLAMMABLE FABRICS ACT STANDARDS

For Further Information Contact:
Margaret L. Neily, Project Manager
Directorate for Engineering Sciences
(301) 504-0508

NOTE: This document has not been reviewed or accepted by the Commission.
Initial MLN Date 1/18/98

CPSA 6 (b)(1) Cleared
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The staff recommends that the Commission update the FFA standards to reference AATCC 124-1996 with the current detergent, laundering procedures, and equipment and issue Notices of Proposed Rulemaking in the *Federal Register* for public comment. The draft Notices for each FFA standard update the references to applicable sections of AATCC 124-1996, "Appearance of Durable Press Fabric after Repeated Home Launderings" to better represent current consumer laundering practices. A 30 day effective date is also recommended.

United States
CONSUMER PRODUCT SAFETY COMMISSION
Washington, D.C. 20207

MEMORANDUM

DATE: NOV 18 1998

TO : The Commission
Sadye E. Dunn, Secretary

Through: Jeffrey S. Bromme, General Counsel
Pamela Gilbert, Executive Director

FROM : Ron Medford, Assistant Executive Director RM
Office of Hazard Identification and Reduction
Margaret L. Neily, Project Manager, ESME
504-0508 Ext. 1293

SUBJECT: Proposed Amendments to Flammable Fabrics Act Standards[1] to Replace Obsolete Standard Detergent and Update Laundering Procedures Required for Tests

I. INTRODUCTION

This memorandum describes the need for updating certain provisions of Flammable Fabrics Act (FFA) standards to ensure that flame resistant properties of children's sleepwear, mattress pads and carpets are maintained during consumer use as originally intended. The detergent specified in these standards is no longer available for compliance testing; and home laundering/clearing practices, equipment, and detergents have changed significantly over the past twenty years. Because the standard test conditions are different from cleaning methods of today, it is possible for certain products to become flammable (as defined by the applicable test) during actual consumer use.

II. BACKGROUND

When the FFA standards were developed, flame retardant (FR) treatments were commonly used, and still are to a lesser extent,

[1] Laundering procedures for 16 CFR 1610, Standard for the Flammability of Clothing Textiles, will be addressed in a separate proceeding covering more extensive revisions.

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Initial MH Date 11/18/98

to achieve the required flammability performance of the various products. To ensure the durability of such treatments through their useful life, products are required to pass flammability tests before and after laundering or cleaning. The cleaning procedure must reflect actual consumer practice so that fire performance characteristics measured by the tests are indicative of real life.

In the early 1970's, five FFA standards were issued incorporating home laundering procedures specified in the voluntary American Association of Textile Chemists and Colorists (AATCC)[2] Test Method 124: "Appearance of Durable Press Fabric after Repeated Home Launderings" (1967, 1969 and 1982 versions). AATCC Test Method 124 specifies a standard reference detergent, laundering equipment, and washing/drying conditions. **(TAB A)**

The following summarizes the FFA standards' provisions for cleaning textile products before flammability testing:

16 CFR 1615 and 1616, Standards for the Flammability of Children's Sleepwear, require tests of sleepwear fabrics or garments after fifty home launderings (AATCC Test Method 124-1969).

16 CFR 1630 and 1631, Standards for the Surface Flammability of Carpets and Rugs, require tests of carpets and rugs treated with a flame retardant after ten home launderings (AATCC Test Method 124-1967).

An alternative washing procedure for wool flokati carpets and rugs specifies ten hand washings with the standard AATCC 124 detergent before testing.

16 CFR 1632, Standard for the Flammability of Mattresses and Mattress Pads, requires tests of mattress pads treated with a flame retardant treatment after ten home launderings (AATCC Test Method 124-1982).

III. AATCC 124 MODIFICATIONS

AATCC updates Test Method 124 periodically, most recently in 1996, to accommodate changes in detergent formulation, washing/drying equipment, and consumer practice. These changes were made with input from a number of AATCC and ASTM committees and a survey of actual consumer practice to better reflect what is currently on the market and used by consumers. **(Tab A)** For this discussion, the "old" detergent and laundering equipment

[2] AATCC is a technical, scientific and educational organization that develops nationally and internationally recognized test methods for the measurement of various performance characteristics of fibers and fabrics.

refer to Standard Reference Detergent 124 and laundering equipment, respectively, specified in early versions of AATCC Test Method 124. The term "new" refers to 1993 AATCC Standard Reference Detergent and the energy-efficient washer and dryer models, all specified in AATCC Test Method 124-1996.

A. Standard Reference Detergent

In the 1970's, states and cities banned phosphate detergents to prevent pollution of rivers and other waterways. The industry responded by gradually standardizing detergents nationwide to non-phosphate formulations. The phosphate-built AATCC Standard Reference Detergent 124, currently required by FFA standards, is a high-phosphate powder with optical brightener, typical of detergents sold to consumers between 1950 and 1970. It was produced for AATCC by a single manufacturer at the request of the industry. AATCC stock of this old detergent is depleted, making it nearly impossible for concerned parties to conduct tests according to the FFA standards.

The new 1993 AATCC Standard Reference Detergent is a non-phosphate, carbonate-built powder formulation. Also produced by a single manufacturer, the new detergent is available from AATCC and represents typical commercial powder formulations available to consumers in 1993 and today. Detergent 1993 is more concentrated than the old detergent, so less is needed for a wash load. In addition to having a slightly larger share of the market than liquid detergents (with a ratio of 51/49), nonphosphate powder detergents are more likely than liquids to adversely affect the flammability of some FR fabrics after laundering (as shown by comparative tests discussed below). **(TAB A)**

B. Laundering Equipment

The technology and design of home laundering equipment have also evolved over the years. The standard home laundering/drying equipment specified in the earlier AATCC 124 standards is no longer manufactured. Energy efficient washers and dryers have taken their place, and consumers typically use cold instead of warm water rinse temperatures. Washing machines today have faster agitator and spin speeds as well as a longer final spin cycle. These changes have also been incorporated in the 1996 version of AATCC Test Method 124.

Table 1 below compares the laundering/drying cycles and conditions specified in the earlier AATCC 124 versions with those of the 1996 version. The changes of significance for this update are shaded and discussed later in more detail.

Table 1. AATCC TEST METHOD 124

WASH/DRY CONDITIONS	VERSIONS 1967,69, & 82	VERSION 1996	
Washing Machine			
Cycle	Normal	Normal/Cotton Sturdy	
Wash Water Temp.	60 ± 3° C	60 ± 3° C	
Rinse Water Temp.	41 ± 3° C	Less Than 29° C	
Water Level	Full	18 ± 1 gal	
Agitator Speed	70 ± 5 spm	179 ± 2 spm	
Wash Time	12 minutes	12 minutes	
Spin Speed	500-510 rpm	630-660 rpm	
Final Spin Cycle	4 minutes	6 minutes	
Dryer			
Cycle	Normal	Cotton Sturdy	Durable Press
Exhaust Temp.	140-160° F	140-160° F	140-160° F
Cool Down Cycle	5 minutes	5 minutes	10 minutes

spm = strokes (or cycles) per minute rpm = revolutions per minute

IV. REVIEW OF EXISTING STANDARDS

In addition to reviewing AATCC Test Method 124-1996, the staff reviewed and analyzed thirteen other international and technical association standards to determine if any are appropriate for consideration in this proceeding. **(TAB A)** Standards and test methods from AATCC, ASTM, the International Standards Organization, the United Kingdom, Australia, Canada, and China were identified. Most of the test methods could be used for sleepwear fabrics and mattress pads; two are specific for carpets.

A. Sleepwear and Mattress Pads

All of the identified standards for fabric laundering have significant deficiencies. They are either based on earlier versions of AATCC Test Method 124 (with obsolete detergent and

equipment), require equipment not available in the U.S., or use only water in the laundering procedure.

B. Carpets and Rugs

The two carpet cleaning methods evaluated (AATCC 138 and a Canadian standard) use a stiff-bristle brush or paint roller, respectively, and two different liquid detergents (sodium laurelsulphate or sodium alkylsulphate). Since these two methods do not involve the typical automatic washing to be updated here, they are both considered inappropriate. The staff has no reason to believe that the automatic washing method of AATCC 124 is now inadequate for the home laundering of FR treated carpets/rugs for which this method of cleaning was previously appropriate. If new products come on the market for which the automatic washing of AATCC 124-1996 is not appropriate, the standards allow the manufacturer to apply for approval of an alternate procedure.

C. Wool Flokati Rugs

An alternate laundering procedure in the FFA carpet and rug standards duplicates the care instructions that manufacturers recommended (to the Federal Trade Commission) for wool flokati rugs. FR treated flokatis must be labeled "Do not wash in home machine or dry clean--Avoid rubbing or brushing while damp." With the alternate laundering procedure, flokati rugs are washed by hand which avoids rubbing and brushing.

The AATCC 138 method which uses the bristle brush is much different than the current hand washing method. Because of the required brushing involved, this method is considered too harsh for flokati rugs. The Canadian method, CAN/CGSB-4.2 No. 30.2-M90, appears more reasonable and may be appropriate for flokati rugs. However, since there are no treated flokatis available for testing, the method cannot be evaluated.

V. IMPACT OF UPDATED PROVISIONS

When an update of a standard is contemplated, it is desirable to determine whether the change has an effect on test results. The old and updated methods may produce different performance test results (pass or fail) with the same FR treated products. No comparison tests of this nature were available from AATCC or others. Although the results of such comparisons would not change the need to update the standard test method to reflect current conditions, they would supply information related to the potential impact of standards amendments. To identify the possible impact of updating the FFA test methods, the staff conducted limited comparison tests of the old AATCC 124 (1967, 1969, and 1982) and new AATCC 124-1996 procedures with potentially affected products.

A. Children's Sleepwear

1. Laboratory evaluation of old and new AATCC methods

The samples of children's sleepwear obtained for laundering method comparison tests included two cotton fabrics with the only two known FR treatments being used (organic phosphorous compound and antimony-trioxide) and two untreated, flame resistant polyester fabrics. FR treated cotton sleepwear represented less than 1% of the children's sleepwear market when CPSC staff conducted these tests. **(Tab B)** All fabrics met the requirements of the children's sleepwear flammability test in their original state (as marketed or after one laundering, as appropriate) and after 50 launderings with the old AATCC detergent and equipment.

For comparison, the staff also determined fabric performance after 50 launderings under a variety of conditions using a limited number of samples. These conditions included those pertinent to the changes between the old and new AATCC 124 methods as well as others of interest. (See **TAB A** for a detailed discussion of the test conditions and analytical results.) Not all fabrics were subjected to all of these laundering conditions:

1. AATCC 124-1996 washing machine and dryer
2. Four wash/rinse temperature conditions (variations of hot, warm and cold)
3. Durable Press drying cycle with 10 minute cool-down representative of current dryer models. A 5 minute cool-down with specified temperature is NOT available on current models.
4. New 1993 AATCC detergent and top-selling liquid and powder detergents commonly available to consumers today
5. Fabric softeners, washer (liquid) and dryer (sheet) types, reported to have an adverse effect on FR polyester fabrics

The fabric test results after launderings indicated that the changes in washing machine and dryer operating conditions in the old and new versions of AATCC Test Method 124 (Table 1 above) do not appear to make a difference in the flammability performance of the fabrics tested in the study.

The detergent type, however, was an important variable for the phosphorous-based FR treated fabric. Pyrovatex CPnew was the most widely used FR treatment for cotton sleepwear. It performed adequately except with the new AATCC detergent and common non-phosphate powder detergents. Staff analysis suggests the reason for this may be the build-up on the fabric of calcium and magnesium which are known to interfere with flame resistance. In contrast the Pyrovatex treated fabric retained its flame resistance when laundered with nonphosphate *liquid* detergents. The antimony-based FR fabric exhibited some specimen failures which were, according to laboratory chemical analyses, apparently

related to problems with the application of the flame retardant rather than the detergent and laundering conditions. **(Tab B)**

The FR polyester fabrics were not adversely affected by the detergents. However, one polyester fabric showed reduced flame resistance with the liquid fabric softener. Both liquid and sheet fabric softener packages contain labels stating that they are not for use on garments labeled as flame resistant.

2. Marketplace changes

After they were notified of the CPSC study results, Ciba Specialty Chemicals,the producer of Pyrovatex CPnew (Pyrovatex), conducted a more comprehensive evaluation of their product and its performance under consumer use conditions. They identified a number of factors that can adversely affect the flame resistance of the light weight fabrics typically used in children's sleepwear. These include characteristics of the fabric, the application process, storage conditions, and consumer care practices. Since Ciba has little or no control over these critical factors, they withdrew Pyrovatex from sale to the sleepwear industry, with one exception[3], early this year. **(Tab C)**

A major retailer that marketed sleepwear treated with Pyrovatex also withdrew its products from sale with public notice to their customers. **(Tab C)**

3. Conclusions

With the exception of the phosphorous-based Pyrovatex-treated fabric, fabric flammability was not adversely affected after 50 launderings under specific conditions of AATCC 124-1996. This suggests that the updated AATCC 124 method with its changes in standard detergent, laundering equipment, and temperature conditions would have little, if any, impact on currently used fabrics that must comply with the children's sleepwear standards.

B. Carpets and Rugs

After considerable effort, the staff was unable to locate flame retardant treated carpets or flokati rugs for a comparison of current vs. updated laundering procedures and detergents. As the market continually changes, the potential for FR treated carpets and rugs returning remains a possibility. The standards need adequate provisions to insure these carpets and rugs maintain their resistance to the spread of flame from a small ignition source. There is no reasonable alternative but to update the laundering procedure, equipment and detergent to

[3] A terry cloth fabric over which Ciba has acceptable control.

reflect current consumer practices, energy-efficient laundering equipment and commonly available detergent.

The AATCC 124-1996 method is suitable for home laundering of large and small FR treated carpets for which laundering in a typical automatic washer is appropriate and required. For the alternate hand-washing method specified for FR treated flokati rugs, the standard detergent would be changed, and the quantity (since the new detergent is concentrated) would be reduced proportionally from 1.5 to 1.1 grams/liter. **(Tab A)** Should these methods be unsuitable for new carpets entering the market, the standard allows manufacturers to apply for approval of an alternate laundering method that is normally used for that type of carpet.

C. Mattress Pads

While the staff was also unable to locate flame retardant treated mattress pads for this comparison of current and updated laundering methods, there continues to be a consumer demand for products made of natural fibers such as cotton. Mattress pads containing cotton sometimes require FR treatment to meet the cigarette ignition resistance requirements of the mattress flammability standard. The AATCC 124-1996 method is suitable for home laundering of FR treated mattress pads previously produced and would be available should these products return to the market place.

D. Economic Issues

Amendments updating the laundering/cleaning procedures referenced in the FFA standards are not expected to have any effect on manufacturers, consumers or other parties. This is because they are already using the AATCC 124-1996 laundering method, equipment, and detergent. **(Tab B)**

VI. CONCLUSIONS

The staff believes that AATCC 124-1996 is the most relevant and appropriate test method identified for representing today's home laundering practices in the United States. The 1993 AATCC Standard Reference Detergent represents typical non-phosphate powder detergents available to consumers. The detergent and the amount used in the alternate laundering procedure for flokati rugs can also be updated while maintaining the appropriate washing method. For the other FFA standards, the Normal/Cotton Sturdy wash cycle and the Durable Press drying cycle (with the 10 minute cool down) are provided by typical laundering equipment of today. These features reflect consumer practice and the collective influence of energy conservation and environmental

protection movements of recent years. Testing laboratories are already using the AATCC 124-1996 laundering method, equipment, and detergent.

Draft FR notices for each of the affected standards are attached in **Tab D**. The proposed rules incorporate specific sections of AATCC 124-1996, where applicable, and update other references to that laundering method. The FR notices also correct obsolete CPSC organization titles (in sleepwear standard sections 1615.32 and 1616.32) and a citation error in 16 CFR 1616.32(g). Since the stock of old standard detergent is depleted and test laboratories are already using the updated detergent and procedures, the staff believes that a 30 day (rather than one year) effective date would be in the public interest.

VII. OPTIONS

1. Make no change in the standard detergent and laundering procedures for the FFA standards.

2. Issue the NPRs to make the recommended changes.

VIII. RECOMMENDATION

The staff recommends that the Commission issue the Notices of Proposed Rulemaking in the *Federal Register* as drafted by the staff for a 75 day public comment period. The notices for each FFA standard update the references to applicable sections of AATCC 124-1996, "Appearance of Durable Press Fabric after Repeated Home Launderings" to better represent current consumer laundering practices. The effective date of the amendments would be 30 days from the date of promulgation.

Tab A

United States
CONSUMER PRODUCT SAFETY COMMISSION
Washington, D.C. 20207

MEMORANDUM

DATE: August 18, 1998

TO : Margaret Neily, Project Manager,
Directorate of Engineering Sciences

Through: Andrew G. Ulsamer, Ph.D., Associate Executive Director, Directorate of Laboratory Sciences AGU

Robert T. Garrett, Director
Division of Engineering

FROM : Gail Stafford, Textile Technologist
Division of Engineering

SUBJECT: Amending the Laundering Provisions of the CPSC Flammability Regulations

The American Association of Textile Chemists and Colorists (AATCC) laundering method specified in the children s sleepwear, carpet/rug and mattress/mattress pad flammability regulations has changed. The AATCC replaced its standard phosphate detergent with a nonphosphate detergent and updated the laundry equipment specified in the AATCC Test Method 124. These changes were made with input from a number of AATCC and ASTM committees and a survey of actual consumer practice to better reflect what is currently on the market and used by consumers. The AATCC published these changes in the revised version of Test Method 124 in its 1997 Technical Manual.

The AATCC laundering method currently used by the Commission in its flammability regulations does not reflect the changes in the AATCC detergent and laundering equipment. In the not too distant future no one will be able to conduct laundering in accordance with the CPSC flammability regulations because the AATCC detergent and laundering equipment currently specified are no longer available. This memorandum discusses the specific AATCC detergent and equipment changes, the AATCC'S reasons for these changes and the impact of these changes on the flammability standards.

BACKGROUND

The following flammability standards require that items of children's sleepwear, carpets/rugs and mattress pads comply with

the regulations before and after laundering:

* 16 CFR 1615/1616, the Standards for the Flammability of Children's Sleepwear;

* 16 CFR 1630/1631, the Standards for the Surface Flammability of Carpets and Rugs;

* 16 CFR 1632, the Standard for the Flammability of Mattresses and Mattress Pads.

The purpose of the laundering provisions in the flammability regulations is to determine durability of the flame resistant properties of the products involved. The children's sleepwear standards require testing fabric and garments as produced or after one laundering (depending on the manufacturer's instructions) and after 50 launderings (whether or not a flame retardant treatment is present). The carpet and rug standards require, however, that if a carpet or rug has a flame retardant (FR) treatment, it must be tested as produced and after 10 launderings. The mattress standard also requires that FR-treated mattress pads be tested as produced and after 10 launderings.

The flammability regulations currently reference older versions (1967, 1969 and 1982) of the AATCC Test Method 124: "Appearance of Durable Press Fabric after Repeated Home Laundering." Each version offers the same choice of three machine wash temperatures and two drying alternatives. All machine washes use the AATCC standard detergent 124, the Normal wash cycle setting and a warm water rinse. Each flammability standard references washing procedure 6.2(III) using a hot water (60±3°C) wash along with drying procedure 6.3.2(B) using the Normal tumble dry setting with a five minute cool down period. Table 1 includes the Normal washer and dryer operating conditions specified in the older versions of the AATCC Test Method 124.

The children's sleepwear standards (§1615.4[g][4] and §1616.5[c][4]) reference the AATCC Test Method 124-1969.[1] The carpet and rug standards (§1630.4[b][1][ii] and §1631.4[b][1][ii]) reference the AATCC Test Method 124-1967,[2] while the mattress standard (§1632.5[b][2]) references the AATCC Test Method 124-1982.[3] The detergent as well as the washing machine and dryer operating conditions are the same in each of the three versions of Test Method 124.

In addition to the laundering procedure specified in the AATCC Test Method 124, the carpet and rug standards contain an alternate washing procedure for FR-treated wool flokati carpets and rugs. The alternative washing procedure (§1630.62[d] and

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[1]Superscript refers to references on page 8.

§1631.62[d]) is a handwashing procedure specifying lukewarm (41°C) wash and rinse water and 1.5 grams per liter of water of the AATCC standard detergent 124 (as specified in AATCC Test Method 124-1967)

AMERICAN ASSOCIATION OF TEXTILE CHEMISTS AND COLORISTS

The American Association of Textile Chemists and Colorists (AATCC) is an organization whose goal is to facilitate education, research and communication within the textile industry. The AATCC develops nationally and internationally recognized test methods for the measurement of various performance characteristics of fibers and fabrics. It is recognized as an authoritative source for test method development within the textile industry in the United States. The AATCC's research committees work continuously to provide the textile industry with methods to accurately predict, measure and evaluate performance characteristics of fabrics. These are consensus methods developed with input from all segments of the textile and apparel industries and are periodically reviewed to reflect new requirements in testing procedures.

MODIFICATIONS TO THE AATCC TEST METHOD 124

DETERGENT

The detergent specified in the 1967, 1969 and 1982 versions of the AATCC Test Method 124 is the AATCC Standard Reference Detergent 124, a high phosphate powder with optical brightener.[4] Standard Reference Detergent 124 represented the type of detergent product used for home laundering in the 1960s that contained 12-14% phosphorous.[5]

Environmental concerns over water pollution subsequently eliminated the use of phosphate in detergent products. As a result, the AATCC replaced its Standard Reference Detergent 124 with Standard Reference Detergent 1993 in Test Method 124-1996. Detergent 1993 is a non-phosphate powder with optical brightener. This carbonate built powder formulation is representative of the types of detergent products on the market in 1993. Standard detergent 1993 is more concentrated than detergent 124 (because it contains more of the surfactant [alkylsulfonate], and less will be used per wash load. Test Method 124-1996 specifies 66 grams of detergent 1993 whereas 90 grams of detergent 124 was used.[5,6,7]

EQUIPMENT

Energy efficient washing machines and dryers sold today have standard conditions that differ from those of older models.[8] Due to the increasing use of cold water washes and rinses over the

years, washing machine operating conditions have changed. Modern washing machines have faster agitator and spin speeds as well as a longer final spin cycle. In the updated version of Test Method 124, the AATCC modified the washing machine conditions and specified a cold water rinse (with all machine washes) to better reflect consumer practices. Test Method 124-1996 offers a choice of hand or machine washing, three machine wash temperatures (41±3°C [105±5°F], 49±3°C [120±5°F], 60±3°C [140±5°F]), three agitation cycles and four drying alternatives. The following table compares the washing and drying conditions specified for the Normal settings (as specified in the flammability regulations) in the 1967, 1969 and 1982 versions of AATCC Test Method 124 with the Normal/Cotton Sturdy washing and drying conditions as well as the Durable Press drying condition specified in the revised 1996 version.

Table 1. AATCC TEST METHOD 124

Shaded areas are the conditions AATCC updated.

WASH/DRY CONDITIONS	VERSIONS 1967,69, & 82	VERSION 1996	
Washing Condition	Normal	Cotton Sturdy	
Wash Water Temp.	60 ± 3°C	60 ± 3°C	
Rinse Water Temp.	41 ± 3°C	Less Than 29°C	
Water Level	Full (no specific volume)	18 ± 1 gal.	
WASHING MACHINE CONDITIONS:			
Agitator Speed	70 ± 5 spm*	179 ± 2 spm*	
Wash Time	12 minutes	12 minutes	
Spin Speed	500-510 rpm**	630-660 rpm**	
Final Spin Cycle	4 minutes	6 minutes	
Drying Condition	Normal	Cotton Sturdy	Durable Press
DRYER CONDITIONS: Exhaust Temp Cool Down Cycle	60-71°C 5 minutes	60-71°C 5 minutes	60-71°C 10 minutes

*spm = strokes per minute **rpm = revolutions per minute

The only tumble dryer condition specified in the 1967, 1969 and 1982 versions of the AATCC Test Method 124 requires exhaust temperatures of 60-71°C (150±10°F) and a five minute cool down

period at the end of the drying cycle. The 1996 version has three tumble dryer conditions: Cotton Sturdy, Delicate and Durable Press (Permanent Press). The Cotton Sturdy and Durable Press conditions both specify high exhaust temperatures of 60-71°C (150±10°F), while the Delicate condition specifies low exhaust temperatures less than 60°C (<140°F). The cooling periods specified are five minutes for the Cotton Sturdy and Delicate settings but 10 minutes for the Durable Press setting. However, clothes dryers on the market today, including the currently AATCC approved electric model, do not have a five minute cool down period with either the Cotton Sturdy or Durable Press setting. Even though the Cotton Sturdy dryer conditions in the 1996 version of Test Method 124 are the same as the Normal conditions in the older versions, the Durable Press dryer conditions are actually more practical and appropriate. Using the Cotton Sturdy dryer condition as specified in Test Method 124-1996, would require timing and stopping the cool down cycle so the test garments are removed promptly after five minutes. Operating the dryer for the complete Durable Press cycle, with the 10 minute cool down period, would represent the dryer conditions available to and used by consumers today.

Test Method 124 also provides a third option for the ballast or dummy load. The 1967 and 1969 versions specified bleached cotton sheeting as the ballast. Included in the 1982 version was the addition of the second option of a 50/50 polyester/cotton bleached and mercerized poplin (plain weave) fabric. The 1996 version includes the addition of the third option of a 50/50 polyester/cotton plain weave fabric. The addition of this option provides for additional flexibility in use of fabrics for ballast.

IMPACT OF DETERGENT AND EQUIPMENT CHANGES ON THE CPSC FLAMMABILITY REGULATIONS

The AATCC's supply of Standard Detergent 124 is now depleted and no longer available.[9] Energy efficient washing machines and dryers sold today have standard settings that differ from those of older models. Late model washing machines do not have a hot wash/warm rinse setting, as specified in the current CPSC flammability regulations. They also have faster agitator and spin speeds as well as a longer final spin cycle; modern dryers have longer cool down periods. As older washing machines and the remaining stock of detergent 124 need to be replaced, it will not be possible to acquire the equipment and detergent necessary to conduct laundering in accordance with the CPSC flammability regulations. The newer dryers while meeting the requirements of the current flammability regulations, would require attended operation if the regulations are not changed.

COMPARATIVE TEST PROGRAM

No test data from outside sources are available comparing the effect of the changes in detergent and equipment conditions on the flammability performance of the products involved. Laboratory Sciences staff have conducted comparative tests to determine whether the flammability performance of items of children's sleepwear before and after laundering according to both the old and new versions of AATCC Test Method 124 is similar[10].

These studies indicated that the flame resistance of some FR cotton fabrics is adversely affected by laundering with the new AATCC standard nonphosphate powder detergent as well as with commercial nonphosphate powder detergents. However, flame retardant cotton fabrics appear to retain their flame resistance when laundered with nonphosphate liquid detergents. The polyester fabrics tested were not affected by the change in detergent. In addition, the changes in washing machine and dryer operating conditions did not appear to make a difference in the flammability performance of those fabrics tested in a comparison of the old and new versions of AATCC Test Method 124.

Staff was originally going to include flame retardant mattress pads, FR wool flokati carpets/rugs and machine washable FR carpets/rugs in the test program but was unable to locate samples.

PROPOSED AMENDMENTS TO THE LAUNDERING PROVISIONS OF THE CPSC FLAMMABILITY REGULATIONS

The laundering provisions in the flammability regulations should be updated to reflect current consumer practice. The AATCC standard phosphate detergent 124 as well as the washing machine and dryer conditions specified in the older versions of the AATCC Test Method 124 are no longer available. Other existing textile laundering standards were evaluated[11], and the best approach at this time is to propose changing the laundering provisions in the flammability regulations to include the updated version of the AATCC Test Method 124. Test Method 124-1996 specifies a nonphosphate powder detergent as well as washing machines and dryers that typify what is on the market and used by consumers today. In addition to having a slightly larger share of the market than liquid detergents (with a ratio of 51/49)[5], nonphosphate powder detergents are more likely to affect the flammability of some FR fabrics after laundering (as shown by the LS comparative tests).

The reference in the laundering provisions of the children's sleepwear (§1615.4[g][4] and §1616.5[c][4]), carpet/rug (§1630.4[b][1][i] and §1631.4[b][1][ii]) and mattress/mattress

pad (§1632.5[b][2]) flammability standards should be changed to the AATCC Test Method 124-1996: "Appearance of Fabrics after Repeated Home Laundering." The reference should be sections 8.2.2 Machine Wash and 8.3.1 (A) Tumble Dry of the AATCC Test Method 124-1996. As stated in "Alternative Washing and Drying Conditions" of Test Method 124, the washing conditions for Machine Cycle, (1) Normal/Cotton Sturdy and Wash Temperatures (V) 60 ± 3°C (140 ± 5°F); as well as drying procedure (A) Tumble: iii Permanent Press (Durable Press) should be used. All machine wash alternatives in Test Method 124-1996 use a cold water rinse (temperature of less than 29°C). The quantity of detergent used per wash load should be 66±0.1 grams of the 1993 AATCC Standard Reference Detergent as stated in Section 8.2.3 of Test Method 124-1996. The changes from the phosphate to the nonphosphate detergent, from the warm water to the cold water rinse and from the five minute to the 10 minute cool down period (using the Permanent Press [Durable Press] drying condition) typify current consumer practice.

In addition, the detergent reference in the alternative washing procedure for FR wool flokati rugs (§1630.62[d] and §1631.62[d]) in the carpet and rug standards should be changed to the AATCC Standard Reference Detergent 1993 as specified in AATCC Test Method 124-1996. Because detergent 1993 is more concentrated than detergent 124, less detergent will be used. The quantity of detergent used should be 1.1 grams per liter of water. Again, the change in detergent reflects current consumer practice.

The acceptance criteria of the standards are not changed by the proposed changes to the washing and drying procedures.

CONCLUSION

In response to the AATCC updating the detergent and laundry equipment in its Test Method 124, the laundering provisions of the CPSC flammability regulations should be amended to include the 1996 version of the AATCC Test Method 124. This method reflects current consumer practices and is based on the results of the LS detergent comparison tests and equipment evaluation as well as the evaluation of other existing textile laundering standards. Additional tests could be conducted if FR-treated mattress pads, FR-treated wool flokati carpets/rugs and machine washable FR-treated carpets/rugs are identified and located. These tests will determine if changing to the new AATCC nonphosphate detergent affects the flammability performance of these products.

REFERENCES

1. AATCC Test Method 124-1969: "Appearance of Durable Press Fabric after Repeated Home Laundering".

2. AATCC Test Method 124-1967: "Appearance of Durable Press Fabric after Repeated Home Laundering".

3. AATCC Test Method 124-1982: "Appearance of Durable Press Fabric after Repeated Home Laundering".

4. AATCC Standard Detergent 124, Composition.

5 AATCC Monograph, "1993 AATCC Standard Reference Detergent and Laundry Detergents in General", May 1998.

6. AATCC Test Method 124-1996: "Appearance of Fabrics after Repeated Home Laundering".

7. AATCC Standard Reference Detergent 1993, Composition.

8. AATCC Document, "Standardization of Home Laundry Test Conditions," Revised May 1995.

9. Phone conversation with Brenda Jones, AATCC, August 7, 1997.

10. Memorandum To Margaret Neily, ES, From Gail Stafford, LSE, and Shing-Bong Chen, LSC, Detergent Comparison Tests, August 1998, Consumer Product Safety Commission.

11. Memorandum To Margaret Neily, ES, From Gail Stafford, LSE, Textile Laundering Standards, August 1993, Consumer Product Safety Commission.

United States
CONSUMER PRODUCT SAFETY COMMISSION

Washington, D.C. 20207

MEMORANDUM

DATE: August 18, 1998

TO : Margaret Neily, Project Manager
Directorate of Engineering Sciences

Through: Andrew G. Ulsamer, Ph. D., Associate Executive Director, Directorate of Laboratory Sciences AGU

Robert T. Garrett, Director
Division of Engineering

FROM : Gail Stafford, Textile Technologist
Division of Engineering

SUBJECT: Textile Laundering Standards

The Commission needs to decide whether to amend its flammability regulations because the laundering method referenced in the regulations has changed. The laundering method currently used by the Commission in its flammability regulations is the American Association of Textile Chemists and Colorists (AATCC) Test Method 124: "Appearance of Durable Press Fabric after Repeated Home Launderings". The 1967, 1969 and 1982 versions of Test Method 124 are referenced in the carpet/rug, children's sleepwear and mattress/mattress pad regulations respectively. The standard phosphate detergent specified in those versions of Test Method 124 is no longer available. Similarly, the washing machines and dryers specified in the current flammability regulations are no longer available. In order to better reflect current consumer laundering practices, the AATCC updated its Test Method 124. The 1996 version of Test Method 124 specifies a standard nonphosphate detergent as well as washer and dryer conditions that represent the types of products available to consumers today.

In order to see if any other textile laundering standards are relevant to the Commission's flammability regulations, the Division of Engineering (LSE) identified a number of textile laundering standards and evaluated them. Fourteen laundering procedures, including the updated 1996 version of the AATCC Test Method 124 were evaluated for their appropriateness for

laundering children's sleepwear, mattress pads, flokati carpets/rugs and machine washable carpets/rugs. In this memorandum each of the international and technical association laundering standards is identified, briefly described and evaluated. Almost all were found not to be relevant.

AMERICAN ASSOCIATION OF TEXTILE CHEMISTS AND COLORISTS (AATCC)

AATCC TEST METHOD 124-1996, APPEARANCE OF FABRICS AFTER REPEATED HOME LAUNDERING

This test method evaluates the smoothness appearance of flat fabric specimens after repeated home laundering. It offers a choice of hand or machine washing, three machine wash temperatures (41±3°C, 49±3°C, 60±3°C), three agitation cycles and four drying alternatives. The washing and drying conditions appropriate for the fabrics tested are selected from the alternatives offered, but the more severe Normal or Cotton Sturdy machine setting is considered most appropriate for evaluating appearance retention. All machine washes specify a cold water rinse, while the hand wash procedure specifies a warm water wash and rinse. The test method recommends five cycles using the AATCC standard 1993 nonphosphate powder detergent.

Currently the flammability regulations reference older versions (1967, 1969 and 1982) of AATCC Test Method 124. These older versions offer a choice of three machine wash temperatures and two drying alternatives. All machine washes use the AATCC standard phosphate detergent 124, the Normal wash setting and a warm water rinse. The laundering provisions in the flammability regulations specify the hot water wash (60±3°C) alternative as well as the Normal tumble dry cycle with a five minute cool down period. In order to be energy efficient, washing machines today do not have a hot wash/warm rinse setting, and their operating conditions are different from older models. In Test Method 124-1996, the Normal/Cotton Sturdy wash cycle reflects the operating conditions of modern washing machines with faster agitator and spin speeds as well as a longer final spin cycle than older models. Dryers sold today have longer cool down periods with the Cotton Sturdy setting, 10 minutes instead of five. The updated version of AATCC Test Method 124 better reflects current consumer practice by specifying a standard nonphosphate powder detergent as well as washer and dryer conditions that are representative of the types of products available to and used by consumers today.

AATCC TEST METHOD 135-1995, DIMENSIONAL CHANGES IN AUTOMATIC HOME LAUNDERING OF WOVEN AND KNIT FABRICS

This test method determines the dimensional changes in woven and knit fabrics when subjected to repeated home laundering procedures. Features specified in the standard are four machine wash temperatures three agitation cycles and four drying alternatives. All wash conditions specify a cold water rinse and the AATCC standard nonphosphate detergent. The washing and drying conditions appropriate for the fabrics tested are selected from the alternatives offered. Five cycles are recommended.

The standard detergent and operating conditions for the washing machine and dryer are the same as AATCC Test Method 124-1996.

AATCC TEST METHOD 143-1996, APPEARANCE OF APPAREL AND OTHER TEXTILE END PRODUCTS AFTER REPEATED HOME LAUNDERING

This test method evaluates the smoothness appearance of flat fabric and seams, and the retention of pressed-in creases in garments and other textile products after repeated home laundering. The choices for washing and drying are the same as in AATCC Test Method 124-1996. Again, five cycles are recommended using the AATCC standard nonphosphate detergent.

AATCC MONOGRAPH: STANDARD LABORATORY PRACTICE FOR HOME LAUNDERING FABRICS PRIOR TO FLAMMABILITY TESTING TO DIFFERENTIATE BETWEEN DURABLE AND NON-DURABLE FINISHES

Besides its test methods, AATCC developed this monograph in 1991. It recommends a standard laboratory procedure to determine the effect of five home launderings on the flammability performance of fabrics. The wash and dry procedures represent a rigorous home laundering. Therefore, a hot water wash/warm water rinse using the Normal or Cotton Sturdy washer setting and a drying cycle set on High are specified. The detergent specified is AATCC Standard Reference Detergent 124, a high phosphate powder detergent. A commonly used commercial detergent is suggested as an alternative, but the monograph does not distinguish between liquid or powder.

AATCC standard detergent 124 is no longer available. AATCC replaced its standard phosphate detergent with a nonphosphate detergent in its laundering test methods, but has not yet changed the reference in this monograph. The washer and dryer models specified are no longer available.

AATCC TEST METHOD 138-1995, CLEANING: WASHING OF TEXTILE FLOOR COVERINGS

This test method simulates changes that occur in a textile floor covering during washing. It can be used to evaluate permanency of finishes and other topical treatments that were applied to the surface pile of textile floor coverings. Features specified in the test method are cleaning agent, scrub brush, extraction unit (laboratory wringer) and drying unit (circulating air oven). The cleaning agent specified is a solution of sodium laurylsulfate detergent. Each specimen is washed by hand scrubbing, rinsed and dried. A scrub brush with stiff bristles is used to work the cleaning solution into the pile surface of the specimens.

This test method is not appropriate for those types of carpets and rugs suitable for laundering in a home washing machine. In addition, care instructions on FR wool flokati rugs in the past indicated that rubbing or brushing while damp should be avoided; gentle kneading of the rug was suggested. The alternate washing procedure currently specified in the carpet and rug standards for FR treated wool flokati carpets and rugs is a handwashing procedure similar to the recommended care instructions. The procedure specifies kneading the back of each specimen in warm water with the AATCC standard phosphate detergent 124, and then rinsing and oven drying the specimens. The scrubbing procedure required in AATCC Test Method 138-1995 may be too harsh for wool flokati rugs.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

D 2960-89, STANDARD TEST METHOD OF CONTROLLED LAUNDERING TEST USING NATURALLY SOILED FABRICS AND HOUSEHOLD APPLIANCES

This test method is used to compare the cleaning and whitening or brightening performance of any pair of home laundering products or procedures. Matched loads of laundry are compared through a series of soiling and washing cycles. Testing is done on naturally soiled garments and household items typical of the washable items found in the home. The washings are performed using two detergents or two laundry additives, or both.

No particular specifications are given for the washing machine and dryer. The standard recommends any automatic washer and clothes dryer in good working condition Features specified in the test method are degree of agitation, water hardness, wash and rinse water temperatures. Ten cycles are recommended.

This test method is suited to the evaluation of laundry products for their cleaning, whitening or brightening properties.

It does not evaluate other performance aspects of textiles such as permanency of flame retardant treatments.

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 6330: 1984, TEXTILES -- DOMESTIC WASHING AND DRYING PROCEDURES FOR TEXTILE TESTING

This test method provides standardized domestic washing and drying procedures for textile fabrics, garments and other textile articles. Features specified in the standard include: water hardness, washing machines (front loading and top loading), five machine wash temperatures, a warm water rinse, five drying alternatives, two agitation cycles, three standard detergents and ironing/pressing. No particular number of cycles are recommended, but each cycle represents a single domestic wash.

All three standard detergents specified are phosphate-built, while the washer and dryer conditions specified are not available on current models in the United States. The ironing/pressing procedure may be inappropriate for children's sleepwear and mattress pads.

ISO 12138, FIRST EDITION 1996, TEXTILES -- DOMESTIC LAUNDERING PROCEDURES FOR TEXTILE FABRICS PRIOR TO FLAMMABILITY TESTING

This test method provides standardized laundering procedures for textile fabrics, garments and other textile articles. It is based on ISO 6330, but incorporates several additional specific requirements. Features specified in this standard besides those in ISO 6330 include: water hardness, volume of wash and rinse water, type and quantity of detergent, four machine wash temperatures, two rinse water temperatures and degree of loading. Twelve cycles are recommended.

Two standard nonphosphate powder detergents (with and without optical brightener) are specified, and each is mixed with a non-chlorine bleaching agent and bleach activator immediately before use. Because this laundering method was designed for home laundering equipment available in other parts of the world, the standard detergents may not be appropriate for use in washing machines available in the United States. As with ISO 6330-1984, the washer and dryer conditions specified are not available on current models in the United States.

BRITISH STANDARDS INSTITUTION (BSI)

BS 5651: 1989, BRITISH STANDARD METHOD FOR CLEANSING AND WETTING PROCEDURES FOR USE IN THE ASSESSMENT OF THE EFFECT OF CLEANSING AND WETTING ON THE FLAMMABILITY OF TEXTILE FABRICS AND ASSEMBLIES

This test method was amended in July 1996, and at that time the text of "Part 5. Domestic Washing Procedures" was deleted to be superseded by BS EN 12138 (ISO 12138). The features specified in British European National Standard (BS EN) 12138 are the same as ISO 12138, "Textiles -- Domestic laundering procedures for textile fabrics prior to flammability testing", discussed above.

BS EN 26330: 1994 (ISO 6330: 1984), TEXTILES -- DOMESTIC WASHING AND DRYING PROCEDURES FOR TEXTILE TESTING

This British European National Standard (BS EN) provides standardized domestic washing and drying procedures for textile fabrics, garments and other textile articles. The features specified in this standard are the same as those in ISO 6330, discussed previously.

STANDARDS ASSOCIATION OF AUSTRALIA (AS)

AS 2001.5.4 -- 1987, METHODS OF TEST FOR TEXTILES PART 5 : DIMENSIONAL CHANGE -- DETERMINATION OF DIMENSIONAL CHANGE IN LAUNDERING OF TEXTILE FABRICS AND GARMENTS -- AUTOMATIC MACHINE METHOD

This standard provides standardized washing and drying procedures for textile fabrics, garments and other textile articles. It is based on ISO 6330. Except for the detergent, all features specified in this standard are the same as in ISO 6330. The Australian standard specifies a standard phosphate-built detergent but allows for the use of other soaps and detergents.

CANADIAN GENERAL STANDARDS BOARD (CGSB)

CAN/CGSB-4.2 No. 58-M90, COLOURFASTNESS AND DIMENSIONAL CHANGE IN DOMESTIC LAUNDERING OF TEXTILES

This standard provides laundering procedures for determining dimensional change and colorfastness of textile fabrics and garments. The washing and drying procedures in this standard are based on those in ISO 6330-1984, "Textiles -- Domestic washing and drying procedures for textile testing". Although the ISO standard specifies a phosphate detergent, this standard specifies a detergent commercially available in Canada with a low phosphate content. One laundering cycle is recommended. As in ISO 6330,

the washing machine and dryer conditions specified are not available on current models in the United States.

CAN/CGSB-4.2 No. 30.3-94, PROCEDURE FOR THE REMOVAL OF NON-PERMANENT FLAME-RETARDANT TREATMENTS FROM TEXTILE PRODUCTS

This standard provides dry cleaning and laundering procedures for removing non-permanent flame-retardant treatments applied to textile products. Items are initially dry cleaned commercially or in a coin-operated type drycleaning machine, then washed in a domestic-type washing machine and dried according to the care instructions of the fabric or apparel manufacturer. One drycleaning and laundering cycle is recommended. The washing machine and dryer are the same as those specified in CAN/CGSB-4.2 No. 58, "Colourfastness and Dimensional Change in Domestic Laundering of Textiles".

It is not clear whether items are washed with neutral chip soap or detergent CAN/CGSB No. 30.3-94 specifies neutral chip soap in paragraph "4. Apparatus and Reagents", but paragraph "7. Procedure" states to wash items in accordance with CAN/CGSB No. 58 which specifies a low phosphate detergent.

CAN/CGSB-4.2 No. 30.2-M90, PROCEDURE FOR THE REMOVAL OF NON-PERMANENT FLAME-RETARDANT TREATMENTS ON TEXTILE FLOOR COVERINGS

This standard provides a laundering procedure for removal, prior to flammability testing, of nonpermanent flame retardant treatments applied to textile floor coverings. Features specified in the test method are cleaning solution, roller, flat bottom container and vacuum cleaner. This is a handwashing procedure using a paint-type roller to work the cleaning solution into the pile of the specimen which is then rinsed. The cleaning treatment is repeated two more times, and then the specimen is dried at room temperature. The standard notes that the paint-type roller is preferred to a brush because it is easy to manipulate, and it spreads the cleaning solution evenly through all types of carpet pile. The cleaning agent specified is a solution of sodium alkylsulphate detergent.

This test method is not appropriate for those types of carpets and rugs suitable for laundering in a home washing machine. For FR wool flokati rugs, the handwashing procedure currently specified in the carpet and rug regulations specifies kneading the back of each specimen in warm water with a standard detergent. Moving a paint-type roller back and forth over the surface of a carpet specimen may be similar to kneading and therefore an appropriate washing technique for flokati rugs.

CHINESE NATIONAL STANDARDS (CNS)

Staff was not able to review the two Chinese standards identified. Contact with the American National Standards Institute (ANSI) indicated that the standards are not available in English, only in Chinese.

CNS L3027, METHOD OF TEST FOR COLOR FASTNESS TO WASHING (MAR) (1494)

The title suggests that this standard contains a laundering procedure for textile products.

CNS LS110, DIMENSIONAL STABILITY OF TEXTILE FLOOR COVERINGS AFTER EXPOSURE TO HEAT AND IMMERSION IN WATER (MAR) (7061)

CNS LS110 is probably not relevant to laundering carpets and rugs. The title is very similar to ISO 2551-1981, "Machine-Made Textile floor coverings - Determination of dimensional changes due to the effects of varied water and heat conditions" and BS 4682: Part 4: 1981, "British Standard Methods of test for Dimensional stability of textile floor coverings. Part 4. Determination of dimensional changes after immersion in water". After reviewing the ISO and BS standards, staff determined that neither of these standards were applicable to laundering carpets and rugs. No cleaning agent or washing procedure is used in either procedure.

DISCUSSION

Almost all of the textile laundering standards evaluated are not relevant to the CPSC regulatory requirements for flammability. Twelve standards were evaluated for their relevancy to laundering children's sleepwear, mattress pads and machine washable carpets and rugs. Of these, seven international standards as well as the AATCC monograph require washing machine and dryer operating conditions and/or phosphate detergents that are outdated and not available in the United States. Washing machines today have faster agitator and spin speeds as well as a longer final spin cycle, while newer dryers have longer cool down periods. Environmental concerns over water pollution have eliminated the use of phosphate in laundry detergents today. The AATCC test methods 124, 135 and 143 are the only standards identified that specify a nonphosphate detergent as well as washing machines and dryers that typify what is on the market and used by consumers today. The ASTM laundering method (D2960-89)is not relevant because it evaluates laundry products, not performance aspects of textiles.

The relevancy, specifically to flokati rugs, of the two laundering standards identified for textile floor coverings

(carpets and rugs) is uncertain at this time. The extent to which either the brush and/or roller may destroy the pile surface of flokati rugs would need to be evaluated. In order to duplicate the manufacturers recommended care instructions, the alternate washing procedure for FR wool flokati rugs (specified in the carpet and rug standards) uses a handwashing procedure.

Laundering practices can influence the flame resistant properties of certain fabrics. The interaction of many variables such as fiber content, FR finish, detergent, water hardness, laundry additives washing conditions and drying methods affect the flammability performance of certain fabrics. The interaction of these variables is complex, and it is difficult to sort out the effects of each variable on the flammability performance of certain fabrics. One common feature among the international textile laundering standards is criteria for water hardness. Water hardness can adversely affect the flammability performance of certain flame resistant fabrics depending on the type of detergent and the FR treatment used. More information is needed however, to determine the appropriateness of including a water hardness criteria in the laundering provisions of the CPSC flammability regulations.

CONCLUSION

Of the textile laundering standards identified, the AATCC Test Method 124-1996 is the method most relevant to the CPSC's flammability regulations. Test Method 124-1996 best reflects current consumer practice for home laundering of children's sleepwear and mattress pads. It specifies a standard nonphosphate detergent as well as washer and dryer conditions that are representative of the types of products used by consumers today.

For those types of FR carpets and rugs suitable for laundering in a home washing machine, the most relevant laundering method at this time is also the updated 1996 version of the AATCC Test Method 124. Updating the laundering procedure, equipment and detergent would better reflect current consumer practice of laundering washable carpets and rugs. In addition, the alternate washing procedure in the carpet and rug standards for FR wool flokati rugs is still the most suitable washing method for this type of rug. By updating the detergent reference to include the AATCC standard nonphosphate 1993 detergent, the alternate washing procedure would better reflect current consumer practice.

United States
CONSUMER PRODUCT SAFETY COMMISSION

Washington, D.C. 20207

MEMORANDUM

DATE: August 19, 1998

TO : Margaret Neily, Project Manager
Directorate of Engineering Sciences

Through: Andrew G. Ulsamer, Ph. D., Associate Executive Director, Directorate of Laboratory Sciences AGU

Robert T. Garrett, Director
Division of Engineering

FROM : Gail Stafford, Textile Technologist
Division of Engineering

Shing Bong Chen, Chemist
Division of Chemistry

SUBJECT: Detergent Comparison Tests

The American Association of Textile Chemists and Colorists (AATCC) laundering method specified in the children's sleepwear, carpet/rug and mattress/mattress pad flammability regulations has changed. The AATCC replaced its standard phosphate detergent with a nonphosphate detergent and updated the laundry equipment specified in the AATCC Test Method 124. These changes reflect what is currently on the market and used by consumers. The AATCC published these changes in the revised version of Test Method 124-1996 in its 1997 Technical Manual.

In contrast to detergents of the 1960-1970 period, environmental concerns over water pollution have eliminated the use of phosphate in detergent products today.[1] To better represent the type of consumer laundry detergent on the market today, AATCC replaced its phosphate powder detergent with a nonphosphate powder detergent. The AATCC Standard Reference Detergent 1993 is now the specified detergent in Test Method 124-1996. In addition, energy efficient washing machines and dryers sold today have operating conditions that differ from those of

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[1]Superscript refers to references on page 22.

older models. In the updated version of Test Method 124, the AATCC updated the washing machine and dryer conditions and specified a cold water rinse to better reflect consumer practices.[2,3]

No test data were available on how the changes in detergent as well as in washers and dryers affect the flammability of laundered products. The Division of Engineering (LSE) conducted comparative tests to determine the effect of these changes in the AATCC detergent and laundry equipment on the flammability performance of children's sleepwear. The purpose of these tests was to determine if any of the above changes could affect compliance flammability test results. The Division of Chemistry (LSC) analyzed fabric samples to determine any chemical changes due to laundering. Flammability and chemical tests were also conducted to determine the effects of commercial detergents, fabric softeners and different wash water temperatures on children's sleepwear flammability. This memo discusses the results of this test program.

Staff originally planned to include flame retardant mattress pads, FR wool flokati carpets/rugs and machine washable FR carpets/rugs in the test program but was unable to locate samples to test.

BACKGROUND

The Standards for the Flammability of Children's Sleepwear, 16 CFR Parts 1615 and 1616, require testing fabric and garments in original state (as produced or after one laundering) and after 50 launderings. The laundering method specified in each of these regulations is the American Association of Textile Chemists and Colorists (AATCC) Test Method 124-1969: "Appearance of Durable Press Fabric after Repeated Home Launderings." This test method offers a choice of three machine wash temperatures and two drying alternatives. All machine washes use the AATCC standard detergent 124, the Normal wash cycle setting and a warm water rinse. The children's sleepwear standards reference washing procedure 6.2(III) using a hot water (60±3°C [140±5°F]) wash along with drying procedure 6.3.2(B) using the Normal tumble dry setting with a five minute cool down period.[4]

Detergent 124 is a high phosphate powder with optical brightener.[5] The AATCC developed Test Method 124 in 1967, and its detergent (124) represented the type of washing product used for home laundering at that time. Detergents contained 12% to 14% phosphorus during the 1960-70 period.[6]

METHODS

GARMENTS

The garments tested were purchased from retailers. Flame retardant-treated (FR) cotton garments from two manufacturers (A and B) were selected along with untreated polyester garments from two manufacturers (C and D). The largest sizes available were purchased. Nightgowns, pajamas and sleepers were included in the test program.

The cotton garments from manufacturer A were treated with a phosphorus-based FR treatment. Two different print patterns were tested due to a limited supply of large sizes at the retailers. Both print patterns were knit fabrics. The floral print fabric weighed 7.9 oz/yd^2, and the cupid print weighed 7.2 oz/yd^2 .

The cotton garments from manufacturer B were treated with an antimony trioxide FR treatment. Again, two different print patterns were tested due to a limited supply of large sizes at the retailers. Both print patterns were knit fabrics. The small floral print fabric weighed 6.6 oz/yd^2, and the large floral print fabric weighed 7.2 oz/yd^2.

Neither of the polyester garments were FR treated. The polyester garment from manufacturer C was a floral print, brushed knit fabric weighing 2.1 oz/yd^2; while the polyester garment from manufacturer D was a fleece knit fabric weighing 5.5 oz/yd^2. Two solid colors of the fleece knit were tested.

DETERGENTS

Both the old phosphate and new nonphosphate AATCC Standard detergents were included in the test program. As specified in AATCC Test Method 124-1969, 90 grams of detergent 124 were used per wash load. Because detergent 1993 is more concentrated, 66 grams were used per load as specified in AATCC Test Method 124-1996.

Besides the AATCC Standard detergents, several commercial nonphosphate detergents were selected for the test program. The two top selling liquid and the three top selling powder detergents were chosen for these studies.[7] In this report the liquid detergents are identified as numbers 1 and 2 and the powder detergents as numbers 3, 4 and 5. The amount of detergent recommended on each detergent container was used per wash load.

Table 1 indicates the laundering condition(s) each detergent was used with.

Table 1.
LAUNDERING CONDITIONS

LAUNDERING CONDITIONS	FABRIC
Hot wash/Cold rinse, "New" Machines AATCC Standard Detergent 1993	A, B
Hot wash/Warm rinse, "Old" Machines AATCC Standard Detergent 124	A, B, C
Hot wash/Warm rinse, "Old" Machines AATCC Standard Detergent 1993	A, B, C
Hot wash/Warm rinse, "Old" Machines Detergent 1, Liquid	A
Hot wash/Warm rinse, "Old" Machines Detergent 2, Liquid	A
Hot wash/Warm rinse, "Old Machines Detergent 3, Powder	A
Hot wash/Warm rinse, "Old" Machines Detergent 4, Powder	A
Hot wash/Warm rinse, "Old" Machines Detergent 5, Powder	A
Cold wash/Cold rinse, "Old" Machines AATCC Standard Detergent 1993	B
Warm wash/Cold rinse, "Old" Machines AATCC Standard Detergent 1993	B
Hot wash/Cold rinse, "Old" Machines AATCC Standard Detergent 1993 Fabric Softener, Liquid	C, D
Hot wash/Cold rinse. "Old" Machines AATCC Standard Detergent 1993 Fabric Softener , Sheet	C, D

LAUNDERING CONDITIONS

Twelve different laundering conditions were used. One condition used washing machines and electric dryers that meet the specifications in the new 1996 version of AATCC Test Method 124. For the other eleven conditions, launderings were conducted using washing machines and electric dryers that meet the specifications in the old 1969 version of Test Method 124. Only garments from the same manufacturer were included in a wash load. Each wash load consisted of garments and ballast (when needed) to make approximately a 4 lb. (1.8 kg) load. As specified in Test Method 124, the ballast was cotton sheets.

For all laundering conditions with the old machines, garments were washed at the Ex High (full) water level washer setting for 12 minutes using the Cotton/Sturdy washer setting as specified in washing procedure 6.2(III) of AATCC Test Method 124-1969. Garments and ballast were tumble dried for approximately 35 minutes with a five minute cool down cycle using the Cotton/Sturdy setting specified in drying procedure 6.3.2(B) of Test Method 124-1969.

Garments laundered with the new machines were washed at the Medium/Large water level setting for 12 minutes using the Heavy Duty washer setting. These washing machine settings were used to meet the washer conditions specified in washing procedure 8.22 (1) Normal/Cotton Sturdy of the AATCC Test Method 124-1996. Garments and ballast were tumble dried for approximately 35 minutes with a 10 minute cool down cycle using the Permanent Press setting specified in drying procedure 8.3.1 (A)(iii) of Test Method 124-1996.

Four different wash/rinse settings were used for various parts of the study: hot/warm, cold/cold, warm/cold and hot/cold. The hot water was 60 ± 3°C (140 ± 5°F), and the warm water was 41 ± 3°C (105 ± 5°F) as defined in AATCC Test Method 124. The cold water was as it came from the tap and ranged in temperature from 11 to 15°C (52 to 59°F).

Fabric softeners were included in the test program because they are common laundry additives, and because a 1993 industry study indicated they may adversely affect the flammability performance of polyester fabrics. Fabric softeners were used with two of the laundering conditions. Both liquid and sheet type fabric softeners were selected for the test program. A liquid and a sheet fabric softener from the top selling commercial brand were chosen.[8] The recommended amount on each container was used per wash load.

Table 1 describes each laundering condition and indicates which fabrics were subjected to each laundering condition. The choice of test fabric for a particular laundering condition was based in part upon experimental findings.

FLAMMABILITY TEST METHOD

All fabric types were tested according to 16 CFR 1615/1616, the Standards for the Flammability of Children's Sleepwear.[9] For each test condition, multiple sets of 5 test specimens were tested. Fabric specimens only were tested, no seams or trims. Conditioned specimens, 3.5 X 10 in. (8.9 X 25.4 cm.), were suspended vertically in holders in a prescribed cabinet and subjected to a flame along their bottom edge for 3 seconds. The char length of each specimen was measured, and the average char length was determined for each set of 5 specimens.

In most cases, 10 specimens were tested from a garment. Specimens were cut in the lengthwise direction of the garments, except where prohibited by small garment size.

Garments were tested in original state and after 25 and 50 cycles for each laundering condition. Original state means as produced (before washing) or after one washing and drying. In order to get an indication of when or if changes in flame resistance take place, one garment was removed from each wash load for flammability testing after 25 cycles. The weight of the remaining wash load was adjusted to approximately 4 lb. (1.8 kg) by the addition of ballast.

TEST CRITERIA

The test criteria for 16 CFR 1615/1616, the Standards for the Flammability of Children's Sleepwear are:

1. the average char length of five specimens cannot exceed 7.0 inches (17.8 cm);

2. no individual specimen can have a char length of 10.0 inches (25.4 cm).

CHEMICAL TEST METHODS

Elemental Analysis of Fabrics

To determine if the flammability test results had a chemical basis, the Division of Chemistry (LSC) identified the elemental components of the fabrics. Analysis was performed using an Inductively Coupled Plasma (ICP) Spectrometer. Staff conducted elemental analysis on fabric samples cut from both unlaundered and laundered garments.

While analyzing for all elements is not practical, the eight elements chosen for analysis are based on those found to be most prevalent in the fabrics after 50 wash cycles. For phosphorus (P), calcium (Ca), magnesium (Mg), aluminum (Al), zinc (Zn), silicon(Si) and boron(B) determinations, approximately 0.1 gram of fabric was weighed and digested with 2 ml of concentrated nitric acid for three to four hours at 120°C. The digest was then diluted with water to a 10 ml solution for ICP determination.

For antimony (Sb), approximately 0.05 gram of fabric was weighed and extracted with 2 ml of 4N hydrochloric acid at room temperature. The extract was diluted with water to a 50 ml solution for ICP determination.

The ICP measurements were done using a Thermal Jarrell Ash model AutoScan 16. To quantitate Antimony, a four point (0, 10, 25, and 100 ppm) calibration curve was used and for other elements, three point (0, 10, 25 ppm) calibration curves were used. The efficiency of recovery of each element from the digest was not determined.

RESULTS

COTTON TREATED WITH PHOSPHORUS FR (Fabric A)

Flammability Tests

The flammability test results for the FR cotton garments from manufacturer A are summarized in Tables 2 and 3. The two print patterns are very similar, and both are treated with a phosphorus-containing flame retardant. Therefore, for this test program the floral and the cupid print patterns were considered to be the same fabric. In original state (before washing), both print patterns met the test criteria.

Test results for launderings done in accordance with both the old (1969) and new (1996) procedures are summarized in Table 2. The floral print pattern tested after 50 hot/warm cycles with detergent 124 using the old machines met the test criteria. But when both the floral and cupid prints were tested after 50 hot/cold cycles with detergent 1993 using the new machines, both fabrics failed to meet the test requirements. Each of the eight sets of specimens had average char lengths greater than 7.0 inches, and 24 individual specimens had 10 inch char lengths.

Table 2.

FABRIC A - FR COTTON

AATCC TEST METHOD 124 - OLD 1969 VERSION vs NEW 1996 VERSION

FLAMMABILITY TEST RESULTS

AVERAGE CHAR LENGTHS FOR EACH SET OF 5 TEST SPECIMENS (inches)							
OLD VERSION - 1969 HOT WASH/WARM RINSE DETERGENT 124				NEW VERSION - 1996 HOT WASH/COLD RINSE DETERGENT 1993			
CUPID PRINT*		FLORAL PRINT*		CUPID PRINT*		FLORAL PRINT*	
AFTER 25 CYCLES	AFTER 50 CYCLES	AFTER 25 CYCLES	AFTER 50 CYCLES	AFTER 25 CYCLES	AFTER 50 CYCLES	AFTER 25 CYCLES	AFTER 50 CYCLES
NT	NT	NT	1.0	NT	9.3[2]	NT	9.6[2]
			1.7		8.9[2]		9.9[1]
			1.7		9.5[1]		10.0[5]
			1.4		8.8[2]		9.9[1]

*The two fabrics are the same except for print pattern.
Solid lines separate results from different garments. Dotted lines separate results of specimen sets from the same garment.
NT means not tested.
Superscript is the number of specimens with 10 inch char length.
Shaded areas are failures.

To determine if changing the detergent affected flammability performance, the fabrics were laundered with standard detergent 1993 using the hot/warm setting of the old machines. Table 3 summarizes the detergent comparison test results. After 25 cycles with AATCC detergent 1993, the cupid print pattern did not meet the test criteria. One specimen had a 10 inch char length. Neither print pattern tested after 50 cycles with detergent 1993 met the test criteria. Each of the eight sets of specimens had average char lengths greater than 7.0 inches, and 22 individual specimens had 10 inch char lengths.

To see if these observations were peculiar to the AATCC detergent 1993, new sleepwear samples were laundered with various commercial detergents in hot/warm cycles using the old machines. As shown in Table 3, both print patterns tested after 25 (or 29) and 50 cycles with both liquid detergents met the test criteria.

Table 3.

DETERGENT COMPARISON TESTS: FABRIC A - FR COTTON

FLAMMABILITY TEST RESULTS

FABRIC	AATCC TEST METHOD 124-1969 ("OLD MACHINES") HOT WASH/WARM RINSE — AVERAGE CHAR LENGTHS FOR EACH SET OF 5 TEST SPECIMENS (inches)															
	BEFORE WASH	AATCC 124 Det		AATCC 1993 Det		DET. 1 LIQUID		DET. 2 LIQUID		DET. 3 POWDER		DET. 4 POWDER		DET. 5 POWDER	
		AFTER 25 CYCLES	AFTER 50 CYCLES	AFTER 25 CYCLES	AFTER 50 CYCLES	AFTER 29 CYCLES	AFTER 50 CYCLES	AFTER 25 CYCLES	AFTER 50 CYCLES	AFTER 29 CYCLES	AFTER 50 CYCLES	AFTER 25 CYCLES	AFTER 50 CYCLES	AFTER 25 CYCLES	AFTER 50 CYCLES
Floral Print Knit* 7.9 oz/yd²	3.2	NT	1.0	NT	8.7[1]	NT	NT	2.3	2.3	8.9[2]	9.8[4]	NT	NT	NT	NT
	1.8		1.7		9.0			2.6**	2.0	9.1[1]	9.8[1]				
	1.4		1.7		9.5[1]				2.7		10.0[5]				
	2.4		1.4		9.2[1]				2.1		9.3[1]				
Cupid Print Knit* 7.2 oz/yd²	1.7	NT	NT	4.8	8.1[1]	4.7	2.6	NT	NT	NT	NT	4.4	7.2[1]	NT	10.0[5]
	1.6			6.6[1]	9.6[1]	3.4	4.0					5.2	6.5[1]		8.8[3]
	1.8				10.0[5]		1.9						6.2		8.2[2]
	2.0				8.5[1]		3.8						7.6[1]		8.5[2]

*The two fabrics are the same except for print pattern.

Solid lines separate results from different garments. Dotted lines separate results of specimen sets from the same garment.

NT means not tested.

Superscript is the number of specimens with 10 inch char length.

Shaded areas are failures.

** Average char length of 4 test specimens cut from crosswise direction of garment.

The floral print pattern tested after 29 cycles with powder detergent #3, however, failed to meet the test criteria. Both sets of specimens had average char lengths greater than 7.0 inches, and 4 individual specimens had 10 inch char lengths. Again after 50 cycles, the floral print pattern did not meet the test criteria. Thirteen individual specimens had 10 inch char lengths, while all four sets of specimens had average char lengths greater than 7.0 inches.

After 25 cycles with powder detergent #4, the cupid print pattern met the test criteria. However, after 50 cycles this print pattern failed to meet the test criteria. Of the four sets of specimens, two had average char lengths greater than 7.0 inches. Three specimens had 10 inch char lengths.

The cupid print pattern tested after 50 cycles with powder detergent #5 also failed to meet the test criteria. All four sets of specimens had average char lengths greater than 7.0 inches, and 12 specimens had 10 inch char lengths.

Chemical Tests

To try to determine why Fabric A failed the flammability test after laundering with the AATCC standard detergent 1993 as well as with various commercial powder detergents, the fabrics were analyzed for the chosen eight elements. Tables 4 and 5 summarize the elemental analysis.

Table 4 lists the percent by weight of P, Mg, Ca, and Al found to be changed in the fabrics washed with various powder and liquid detergents using the old machines. Although the phosphorus content decreased after laundering, there appeared to be no consistent relationship between char length and phosphorus concentrations alone. The decrease in phosphorus was similar for both the standard and commercial detergents. For example, the floral print passes with the old detergent at 1.88% P and fails with the new detergent at 1.80% P. However, all powder detergents except AATCC standard 124 (high phosphate) resulted in elevated concentrations of Mg and to a lesser extent of Ca after laundering. The average of char lengths for the fabrics increased as the concentrations of Mg and Ca increased and the concentration of P decreased. For example, powder detergent #3 gave an average char length of 9.7 inches when the concentrations of Mg and Ca were 0.46 and 0.94 percent by weight respectively, and the concentration of P was 1.72%. Whereas liquid detergent #2 gave an average char length of 2.3 inches when the concentrations of Mg and Ca were 0.04 and 0.27 percent by weight respectively, while the concentration of P was 2.05%. The case

is less clear for the cupid print and liquid detergent # 1 where the P concentration is low but so is the Mg concentration. Observed increases in the concentrations of these elements on the fabrics are probably caused by the presence of Mg and Ca in the water. It is possible that these ions may increase flammability in some instances by binding the sulfonate detergents (surfactants) that are more often used in powder than liquid detergents.

Table 4.
ELEMENTAL ANALYSIS OF FABRIC A - FR COTTON
DETERGENT COMPARISON
HOT WASH/WARM RINSE & OLD MACHINES

FABRIC	DETERGENT	WASH CYCLES	PASS/ FAIL	AVERAGE CHAR LENGTH* (inches)	%WT P	%WT Mg	%WT Ca	%WT AL
Floral Print**	--	0	P	2.2	2.50	0.06	0.38	0.01
	Std. 124 powder	50	P	1.5	1.88	0.03	0.24	0.04
	Std. 1993 powder	50	F	9.2	1.80	0.44	0.54	0.33
	Det. 3 powder	50	F	9.7	1.72	0.46	0.94	0.20
	Det. 2 liquid	50	P	2.3	2.05	0.04	0.27	0.03
Cupid Print**	--	0	P	1.8	2.33	0.05	0.30	0.01
	Std. 1993 powder	25	F	5.7	1.92	0.13	0.33	0.11
	Std. 1993 powder	50	F	9.4	1.61	0.22	0.29	0.12
	Det. 4 powder	25	P	4.8	2.09	0.14	0.36	0.09
	Det. 4 powder	50	F	6.9	1.84	0.15	0.39	0.06
	Det. 3 powder	50	F	8.1	1.85	0.20	0.98	0.09
	Det. 1 liquid	25	P	4.1	1.57	0.04	0.18	0.01
	Det. 1 liquid	50	P	3.1	1.73	0.07	0.27	0.05

*Average char length of all specimens tested.
**The two fabrics are the same except for print pattern.
Shaded areas are flammability test failures.

The aluminum content also increased somewhat after laundering as shown in Table 4. This may result from the deposit of the aluminosilicate builders in the detergents. Most of the nonphosphate powder detergents contain higher concentrations of Al than the AATCC 124 standard phosphate powder or the liquid detergents.

Table 5 shows Fabric A consistently failed the flammability test after laundering with detergent 1993 using both the old and new versions of AATCC Test Method 124. The elemental data in Table 5 continues to suggest that combinations of decreased P and elevated Mg and Ca concentrations are associated with failure to pass the flammability test.

Table 5.
ELEMENTAL ANALYSIS OF FABRIC A - FR COTTON
AATCC TEST METHOD 124 - OLD 1969 VERSION vs NEW 1995 VERSION
USING AATCC DETERGENT 1993

FABRIC	WASH CYCLES	OLD/NEW MACHINES	WASH/ RINSE	PASS/ FAIL	%WT P	%WT Mg	%WT Ca	%WT AL
Floral Print*	0	N/A	N/A	Pass	1.73	0.04	0.28	0.01
	50	Old	Hot/Warm	Fail	1.54	0.34	0.41	0.25
	50	New	Hot/Cold	Fail	1.44	0.29	0.89	0.19
	0	N/A	N/A	Pass	1.76	0.04	0.25	0.02
	0	N/A	N/A	Pass	2.50	0.06	0.38	0.01
	50	Old	Hot/Warm	Fail	1.80	0.44	0.54	0.33
Cupid Print*	0	N/A	N/A	Pass	1.63	0.04	0.22	0.01
	50	Old	Hot/Warm	Fail	1.72	0.23	0.29	0.11
	50	New	Hot/Cold	Fail	1.54	0.16	0.62	0.08
	0	N/A	N/A	Pass	2.08	0.04	0.27	0.02
	0	N/A	N/A	Pass	2.33	0.05	0.30	0.01
	50	Old	Hot/Warm	Fail	1.61	0.22	0.29	0.12

*The two fabrics are the same except for print pattern.
Shaded areas are flammability test failures.

COTTON TREATED W TH ANTIMONY TRIOXIDE FR (Fabric B)

Flammability Tests

The flammability test results for the antimony trioxide FR cotton garments from manufacturer B are summarized in Tables 6 and 7. For this test program both the small and the large floral print patterns were considered to be the same fabric. These garments were labeled "Wash Before Wearing" and so were tested after one hot wash/warm rinse cycle with each of the AATCC standard detergents using the old machines. Both print patterns tested after each of these laundering cycles met the test criteria.

The test results for launderings performed in accordance with both the old and new procedures of Test Method 124 are summarized in Table 6. The small floral print pattern met the test criteria after 25 and 50 hot/warm cycles with AATCC detergent 124 using the old machines. After 50 hot/cold cycles with detergent 1993 using the new machines, the small floral print also met the test criteria, but two of the four sets of the large floral print failed. Each of these two sets of specimens had average char lengths equal to 7.0 inches with four individual specimens having 10 inch char lengths. The remaining two sets had char lengths less than seven inches but showed variation in char lengths with this fabric.

Table 6.
FABRIC B - FR COTTON
AATCC TEST METHOD 124 - OLD 1969 VERSION vs NEW 1996 VERSION
FLAMMABILITY TEST RESULTS

AVERAGE CHAR LENGTHS (INCHES) FOR EACH SET OF 5 TEST SPECIMENS Superscript is the number of specimens with 10 inch char length							
OLD VERSION - 1969 HOT WASH/WARM RINSE DETERGENT 124				NEW VERSION - 1996 HOT WASH/COLD RINSE DETERGENT 1993			
SMALL FLORAL PRINT*		LARGE FLORAL PRINT*		SMALL FLORAL PRINT*		LARGE FLORAL PRINT*	
AFTER 25 CYCLES	AFTER 50 CYCLES	AFTER 25 CYCLES	AFTER 50 CYCLES	AFTER 25 CYCLES	AFTER 50 CYCLES	AFTER 25 CYCLES	AFTER 50 CYCLES
1.4	2.6	NT	NT	NT	3.6	NT	7.0^{1}
2.0	2.7				3.8		3.2
	3.6				3.0		5.3
	2.7				3.6		7.0^{3}

*The two fabrics are the same except for print pattern.
Solid lines separate results from different garments. Dotted lines separate results of specimen sets from the same garment.
NT means not tested. Shaded areas are failures.

Table 7. **FABRIC B - FR COTTON**
AATCC DETERGENT 124 vs AATCC DETERGENT 1993
FLAMMABILITY TEST RESULTS

AATCC TEST METHOD 124-1969 ("OLD MACHINES") HOT WASH/WARM RINSE												
AVERAGE CHAR LENGTHS (INCHES) FOR EACH SET OF 5 TEST SPECIMENS Superscript is the number of specimens with 10 inch char length.												
SMALL FLORAL PRINT PATTERN* Knit 6.6 oz/yd²						**LARGE FLORAL PRINT PATTERN*** Knit 7.2 oz/yd²						
AATCC 124			**AATCC 1993**			**AATCC 124**			**AATCC 1993**			
AFTER 1 CYCLE	AFTER 25 CYCLES	AFTER 50 CYCLES	AFTER 1 CYCLE	AFTER 25 CYCLES	AFTER 50 CYCLES	AFTER 1 CYCLE	AFTER 25 CYCLES	AFTER 50 CYCLES	AFTER 1 CYCLE	AFTER 25 CYCLES	AFTER 50 CYCLES	
2.5	1.4	2.6	1.5	1.8	7.4[1]							
2.0	2.0	2.7	1.5	1.7	2.6							
2.0		3.6	1.5		2.0							
2.0		2.7	1.6		3.3							
					2.9	2.4	NT	NT	1.6	NT	8.8[1]	
					2.9	1.8			1.9		10.0[5]	
					2.2	2.2			2.1		2.3	
					2.5	1.6			2.3		2.3	
					4.0						4.1	
					2.7						4.1	
					2.3						2.7	
					2.5						2.1	
					3.0						2.9	
					3.1						2.8	
					2.3						2.7	
					2.4						2.9	
					1.8						2.0	
					2.5						2.3	
					2.9						2.3	
					2.5						2.0	
					2.1						4.3	
					2.5						4.7	
					3.4						6.5[1]	
					2.8						5.3	

Solid lines separate results from different garments. Dotted lines separate results of specimen sets from the same garment.
NT means not tested. Shaded areas are failures. *The two fabrics are the same except for print pattern.

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To determine if a change in detergent alone affected flammability performance, the small floral print was laundered with detergent 1993 using the hot/warm setting of the old machines. Table 7 summarizes the detergent comparison test results. The first set of specimens of the small floral print fabric tested after 50 cycles did not meet the test criteria. This set of specimens had an average char length greater than 7.0 inches, with one specimen having a 10 inch char length. Because of the variation in char lengths with these test results, staff decided to do additional tests using the old machines and the new 1993 detergent.

In order to do the additional tests, more Fabric B garments had to be obtained. Since only a limited number of the small floral print garments could be located in stores, a number of the large floral print garments were also purchased. Ten additional garments of the small floral print as well as 10 garments of the large floral print were laundered. Ten garments of the same print pattern were laundered together in hot/warm cycles with detergent 1993 using the old machines. All 20 additional sets of the small floral print tested after 50 cycles met the test criteria. However, four of the 20 sets of specimens of the large floral print pattern did not meet the test criteria after 50 hot/warm cycles with detergent 1993. Two sets of specimens had char lengths greater than 7.0 inches, with nine specimens having 10 inch char lengths. Even though the other two sets of specimens did not have average char lengths greater than 7.0 inches, each set of five specimens had one specimen with a 10 inch char length. These results indicate what appears to be a problem with the application of the antimony trioxide to these fabrics.

Chemical Tests

To try to determine why only some of the Fabric B samples failed the flammability test after laundering with the AATCC standard nonphosphate detergent, samples were analyzed for Sb, Mg,Ca, and Al.

Table 8 shows the amount of antimony (Sb) decreases with repeated hot wash/warm rinse cycles using the old machines. Further, the table shows the fabrics that failed the flammability tests had considerably less than three percent by weight of antimony, but not all fabrics with less than three percent antimony failed the flammability tests. Overall the results show Mg,Ca and Al levels increased, as with Fabric A, after repeated laundering with the AATCC 1993 detergent compared to the AATCC 124 detergent. However, concentrations of these elements do not differ appreciably between failing and passing specimens of Fabric B using the 1993 detergent.

Table 8.

ELEMENTAL ANALYSIS OF FABRIC B - FR COTTON

AATCC DETERGENT 124 vs AATCC DETERGENT 1993

HOT WASH/WARM RINSE & OLD MACHINES

FABRIC	DETERGENT	WASH CYCLE	PASS/ FAIL	%WT Sb	%WT Mg	%WT Ca	%WT Al	GARMENT NUMBER
Small Floral Print*	–	0	NT	4.67	0.01	0.05	0.00	
	Std. 124	1	P	5.18	0.01	0.06	0.00	
	Std. 124	25	P	3.51	0.01	0.06	0.00	
	Std. 124	50	P	2.83	0.01	0.08	0.01	
	Std. 1993	1	P	5.35	0.01	0.09	0.02	
	Std. 1993	25	P	3.74	0.06	0.16	0.09	
	Std. 1993	50	F	2.29	0.19	0.25	0.12	garment #2, front
	Std. 1993	50	P	2.59	0.25	0.24	0.13	garment #2, back
	Std. 1993	50	P	3.22	0.17	0.26	0.11	garment #4, spec. 7-2
	Std. 1993	50	P	2.99	0.18	0.28	0.12	garment #4
Large Floral Print*	–	0	NT	4.99	0.00	0.02	0.00	
	Std. 124	1	P	5.08	0.01	0.07	0.00	
	Std. 1993	1	P	5.30	0.02	0.10	0.02	
	Std. 1993	50	F	2.09	0.30	0.28	0.14	garment #1, spec. 1-1
	Std. 1993	50	F	2.03	0.26	0.27	0.13	garment #1
	Std. 1993	50	P	3.15	0.20	0.28	0.10	garment #2, spec. 3-5
	Std. 1993	50	P	2.49	0.19	0.21	0.09	garment #2

*The two fabrics are the same except for print pattern.
NT means not tested for flammability.
Shaded areas are flammability test failures.

Both unburned fabric pieces and unburned portions of actual test specimens from the same garment were analyzed. This was done to see if tested fabrics showed a better relationship to the concentrations of elements. For example, Table 8 shows that samples of unburned fabric from large floral print garment #1 (that failed the flammability test) and test specimen 1-1 (with a 10 inch char length) gave similar concentrations of all elements. The results for small floral print garment #4 (that passed the flammability test), however, also showed similar concentrations of all elements.

POLYESTER (Fabrics C and D)

Flammability Tests

The flammability test results for the polyester garments from manufacturers C and D are presented in Table 9.

In the original state, both Fabrics C and D met the test criteria. Fabric C was tested before washing, while Fabric D (labeled "Wash Before Wearing") was tested after one hot/warm cycle with each AATCC standard detergent using the old machines. All launderings were done using the old machines. After 25 and 50 hot wash/warm rinse cycles each with AATCC detergents 124 and 1993, Fabric C met the test criteria.

To duplicate laundry conditions likely to be used by consumers, these fabrics were laundered in hot wash/cold rinse cycles with fabric softeners. Liquid fabric softener was added to each rinse cycle, and sheet fabric softener was added to each drying cycle. After 25 and 50 cycles with both liquid and sheet fabric softeners, Fabric C met the test criteria. Fabric D met the test criteria after 25 cycles with the liquid softener and after 25 and 50 cycles with the sheet softener. However, after 50 cycles with the liquid fabric softener, two of the four sets of specimens failed to meet the test criteria. Even though the average char length of each of these two sets of the turquoise color specimens was less than seven inches, three specimens had 10 inch char lengths; while the two sets of pink specimens met the test criteria.

Table 9.

FABRICS C & D - POLYESTER
AATCC DETERGENT 124 vs AATCC DETERGENT 1993 AND FABRIC SOFTENERS
FLAMMABILITY TEST RESULTS

FABRIC	ORIGINAL STATE	AATCC TEST METHOD 124-1969 ("OLD MACHINES") AVERAGE CHAR LENGTHS (INCHES) FOR EACH SET OF 5 TEST SPECIMENS Superscript is the number of specimens with 10 inch char length							
		AATCC 124 HOT/WARM		AATCC 1993 HOT/WARM		AATCC 1993 HOT/COLD LIQUID FABRIC SOFTENER		AATCC 1993 HOT/COLD SHEET FABRIC SOFTENER	
		AFTER 25 CYCLES	AFTER 50 CYCLES	AFTER 25 CYCLES	AFTER 50 CYCLES	AFTER 25 CYCLES	AFTER 50 CYCLES	AFTER 25 CYCLES	AFTER 50 CYCLES
Fabric C: Floral Print, Brushed Knit 2.1 oz/yd²	4.9	3.2	3.3	3.7	3.8	2.8	3.5	4.0*	3.4
	4.3	3.2	2.9	3.4	4.1	3.0	3.3	3.5*	3.2
	4.0		3.4		3.2		2.7		3.6
	4.1		3.5		3.4		3.8		3.5
Fabric D: Solid color, Fleece Knit 5.6 oz/yd²	3.4 T**	NT	NT	NT	NT	4.2 T	6.8 T	2.1 P	1.9 T
	3.8 T**					3.7 T	6.3 T	1.9 P	2.0 T
	2.6 T***						2.1 P		2.5 P
	3.4 T***						5.4 P		2.3 P

Solid lines separate results from different garments. Dotted lines separate results of specimen sets from the same garment. NT means not tested. Shaded areas are failures.
* After 26 cycles.
**After one hot/wash cycle w/AATCC detergent 124.
*** After one hot/wash cycle w/AATCC detergent 1993.
T means turquoise color. P means pink color.

Chemical Tests

No detectable amounts of elements were found on polyester Fabrics C and D in original state (before and/or after one wash cycle with each AATCC detergent) and on Fabric C after hot/warm cycles with detergents 124 and 1993. However, laundering with liquid fabric softener did result in deposition of elements on both Fabrics C and D. Table 10 shows concentrations of calcium and magnesium were higher on both fabrics after 25 and 50 cycles with the liquid softener than with the sheet softener. The effects of these deposits on the flame resistance of the polyester fabrics tested is not clear since the failing Fabric D was not very different from the passing Fabric D. An alternate possibility is that the liquid softener itself deposited on the fabric and affected the fleece knit fabric more than the brushed knit fabric.

Table 10.

ELEMENTAL ANALYSIS OF FABRICS C & D - POLYESTER
LAUNDERED WITH FABRIC SOFTENERS
AATCC STANDARD DETERGENT 1993 & OLD MACHINES

FABRIC	WASH/RINSE	WASH CYCLE	PASS/ FAIL	FABRIC SOFTENER	%WT Mg	%WT Ca	%WT Al	%WT Si	%WT Na
Fabric C: Floral Print, Brushed Knit	hot/cold	25	P	liquid	0.22	1.66	2.42	1.83	0.15
	hot/cold	50	P	liquid	0.20	0.75	1.11	0.98	0.07
	hot/cold	26	P	sheet	0.02	0.03	0.02	0.02	0.01
	hot/cold	50	P	sheet	0.01	0.02	0.02	0.02	0.01
Fabric D: Solid color, Fleece Knit	hot/cold	25	P (T)*	liquid	0.10	1.04	1.52	1.24	0.10
	hot/cold	50	P (P)**	liquid	0.25	1.40	2.05	1.76	0.13
	hot/cold	50	F (T)	liquid	0.32	1.75	2.57	2.46	0.16
	hot/cold	26	P (P)	sheet	0.01	0.01	0.02	0.02	0.01
	hot/cold	50	P (P)	sheet	0.02	0.01	0.02	0.02	0.01

* (T) means turquoise color.
**(P) means pink color.
Shaded areas are flammability test failures.

DISCUSSION

The FR treated cotton and polyester fabrics passed the flammability tests in original state and after laundering with the old AATCC standard phosphate detergent. Comparing the old and new versions of AATCC Test Method 124, the changes in washing machine and dryer operating conditions did not appear to make a difference in the flammability performance of the fabrics tested. The cotton fabric with the phosphorus-based FR treatment, however, performed worse after laundering with the standard and commercial nonphosphate powder detergents than the antimony treated fabric. This did not seem to be strictly related to loss of FR treatment, since the loss of phosphorus was as great overall with the AATCC 124 phosphate detergent. The tendency of the phosphorous FR treated fabric (Fabric A) to fail seemed to increase as calcium and magnesium concentrations increased. Fire retardancy in cellulosic fabrics is known to be adversely affected by calcium and magnesium salts. The literature indicates that carbonate-built detergents generally have greater adverse effects on phosphate-based fire retardants than phosphate-built detergents (see footnote below).[10,11]

Nonphosphate liquid detergents, that are either citrate-built or unbuilt surfactant products[6], have less of an effect on the flammability characteristics of fabrics. With these detergents there is less tendency towards the formation of salt deposit build-up on fabrics during laundering.[11] The cotton fabric (Fabric A) with the phosphorus-based FR treatment passed the flammability test after repeated laundering with nonphosphate liquid detergents.

It is not clear why only some of the antimony trioxide FR treated cotton failed the flammability test after repeated laundering with the AATCC nonphosphate detergent. The failures appear to be associated at least in part with a decrease in the FR. While some role may be played by Ca and Mg build-up, it is not as apparent as with the phosphorus FR treated cotton. Quality control of the application of the FR treatment may also be a problem. The failures with both the small floral and large

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Detergents consist of surfactants and builders. The surfactant is a detergent's basic cleaning ingredient, while the builder helps the surfactant penetrate and loosen soil.[12] Phosphates are excellent builders. But because of environmental concerns, today powder detergent substitutes for phosphates are carbonates and aluminosilicates. The AATCC standard detergent 1993 and commercial powder detergents contain both sodium carbonate and aluminosilicate builders.[3,13]

floral print garments indicate a problem with the application of antimony trioxide to these fabrics. Most test sets passed the flammability test. Other unidentified factors may also play a role including local variation in antimony concentration.

The brushed knit polyester fabric also passed the flammability test after launderings with both the AATCC standard phosphate and nonphosphate detergents. Use of a liquid fabric softener, however, caused the fleece knit polyester to fail two of the four flammability tests. The brushed knit did not fail with either the liquid or sheet fabric softener tested. The liquid fabric softener did cause an accumulation of Ca, Mg, Al and Si, but levels were similar in both polyester fabrics. Both liquid and sheet fabric softener packages contain labels stating that they are not for use on garments labeled as flame resistant.

CONCLUSIONS

These tests were conducted to give an overview of various laundering parameters that might influence the flame resistance of children's sleepwear. Detergent is the one variable that these studies identify as influencing the flammability performance of children's sleepwear. The flame resistance of certain FR treated cotton fabrics is adversely affected by laundering with nonphosphate powder detergents. This is shown by the consistent loss of flame resistance of the phosphorous FR treated cotton fabric after repeated laundering with both the standard AATCC and various commercial nonphosphate powder detergents. The phosphorus FR cotton fabrics, however, retained their flame retardancy when laundered with nonphosphate liquid detergents. Some antimony FR treated cotton fabric test sets also failed after repeated laundering with the standard AATCC nonphosphate powder detergent, but more passed. These results indicate that variability in the application of the antimony FR to this fabric, rather than laundering with the nonphosphate detergent, affected its flammability.

The flammability performance of polyester fabrics is not adversely affected by laundering with the AATCC nonphosphate powder detergent. The flame resistance of some polyester fabrics may be reduced when liquid fabric softener is added to the rinse cycle.

REFERENCES

1. AATCC Document, "AATCC Standard Detergent 124 and Laundry Detergents in General", Revised May 1991.

2. AATCC Test Method 124-1996: "Appearance of Fabrics after Repeated Home Laundering".

3. AATCC Standard Reference Detergent 1993, Composition.

4. AATCC Test Method 124-1969: "Appearance of Durable Press Fabric after Repeated Home Launderings".

5 AATCC Standard Reference Detergent 124, Composition.

6. AATCC Monograph, "1993 AATCC Standard Reference Detergent and Laundry Detergents in General", May 1998.

7. "The Market Leaders", happi, January 1997.

8. Information Access, Co., 1997 and Advertising Age.

9. 16 CFR 1615, the Standard for the Flammability of Children's Sleepwear, Sizes 0-6X; 16 CFR 1616, the Standard for the Flammability of Children's Sleepwear, Sizes 7-14.

10. Flame Resistant Textiles Handbook, Reeves, Drake and Perkins, 1974, pp. 233-241.

11. "Effects of Home Laundering Practices and Wear on Flame Resistant Fabrics: A Literature Survey", Shimasaki, Neily and Thomas, 1976.

12. "Soaps and Detergents", The Soap and Detergent Association, 1994.

13. Ingredient labeling on commercial detergent containers.

Appearance of Fabrics after Repeated Home Laundering

Developed in 1967 by AATCC Committee RA61; revised 1969, 1975, 1982, 1989 (with title change), 1992, 1996; editorially revised 1974, 1983, 1985, 1988, 1991; reaffirmed 1973; editorially revised and reaffirmed 1978, 1984. Similar to ISO 7768.

1. Purpose and Scope

1.1 This test method is designed for evaluating the smoothness appearance of flat fabric specimens after repeated home laundering.

1.2 Any washable fabric may be evaluated for smoothness appearance using this method.

1.3 Fabrics of any construction, such as woven, knit and nonwoven, may be evaluated according to this method.

1.4 This test method shall not be construed to provide a standard of performance for any textile item, but only a standard method by which to evaluate performance of the item.

2. Principle

2.1 Flat fabric specimens are subjected to standard home laundering practices. A choice is provided of hand or machine washing, alternative machine wash cycles and temperatures, and alternative drying procedures. Evaluation is performed using a standard lighting and viewing area by rating the appearance of specimens in comparison with appropriate reference standards.

3. Terminology

3.1 **ballast,** n.—*in procedures for processing or testing of textiles,* material that is used to bring the total weight or volume of the textiles to an amount specified in the procedure.

3.2 **dryer creases,** n.—sharp folds or lines running in any direction in a laundered or dried specimen. *Note:* Dryer creases are an unintended result of restricted movement of specimens in the washer or the dryer.

3.3 **durable press,** adj.—having the ability to retain substantially the initial shape, flat seams, pressed-in creases and unwrinkled appearance during use and after laundering or drycleaning.

3.4 **laundering,** n.—*of textile materials,* a process intended to remove soils and/or stains by treatment (washing) with an aqueous detergent solution and normally including rinsing, extracting and drying.

3.5 **smoothness appearance,** n.—*in fabrics,* the visual impression of planarity of a specimen quantified by comparison with a set of reference standards.

4. Safety Precautions

NOTE: These safety precautions are for information purposes only. The precautions are ancillary to the testing procedures and are not intended to be all inclusive. It is the user's responsibility to use safe and proper techniques in handling materials in this test method. Manufacturers MUST be consulted for specific details such as material safety data sheets and other manufacturer's recommendations. All OSHA standards and rules must also be consulted and followed.

4.1 Good laboratory practices should be followed. Wear safety glasses in all laboratory areas.

4.2 The 1993 AATCC Standard Reference Detergent may cause irritation. Care should be taken to prevent exposure to skin and eyes.

4.3 All chemicals should be handled with care.

4.4 Manufacturer's safety recommendations should be followed when operating laboratory testing equipment.

5. Uses and Limitations

5.1 This test method is designed to be used only for evaluating the appearance of washable fabrics after repeated home laundering.

5.2 The test procedure is designed to reflect the capabilities of home laundry equipment which is currently used by consumers. In general, it is preferable to conduct the test under relatively severe laundering conditions.

5.3 Prints and patterns may mask the mussiness present in fabrics. The rating process is, however, based on the visual appearance of specimens including such effects.

5.4 The small specimen sizes used for fabric tests occasionally will cause wrinkles or creases (dryer creases) to develop which are not considered to be characteristic of fabric performance in use. Precautions are given in the text of the method to reduce the occurrence of dryer creases.

5.5 The interlaboratory reproducibility of the results of this test method depends upon mutual agreement by users of the method on the washing and drying conditions as outlined in section 8.1.

6. Apparatus and Materials

6.1 Automatic washing machine (see 12.1).

6.2 Automatic tumble dryer (see 12.1).

6.3 Drip dry and line dry facilities.

6.4 A 9.5 liter (10.0 qt) pail.

6.5 1993 AATCC Standard Reference Detergent (see 12.2 and 12.8).

6.6 Ballast of 92.0 × 92.0 cm (36.0 × 36.0 in.) hemmed pieces of bleached cotton sheeting (Wash load ballast type 1) or 50/50 polyester/cotton bleached and mercerized poplin (Wash load ballast type 2), or 50/50 polyester/cotton plain weave (Wash load ballast type 3) (see 12.3).

6.7 Lighting and evaluation area in an otherwise darkened room using the overhead lighting arrangement shown in Fig. 1 (see 12.4). It has been the experience of many observers that light reflected

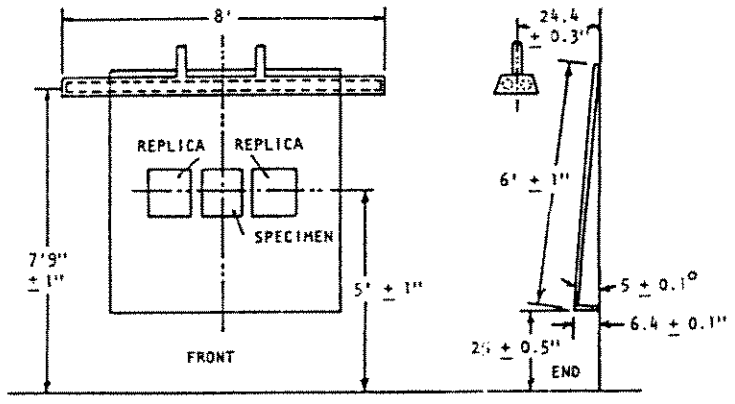

Fig. 1. Lighting equipment for viewing test specimens. Materials list: (a) Two 8-ft Type F96 CW (Cool White) preheat Rapid Start fluorescent lamps (without baffle or glass). (b) One white enamel reflector (without baffle or glass). (c) One general type swatch mount, spring loaded. Fabricate using light sheet metal (22 ga.) (d) One ¼ in. plywood mounting board painted to match No. 2 gray chip on AATCC Gray Scale for Staining.

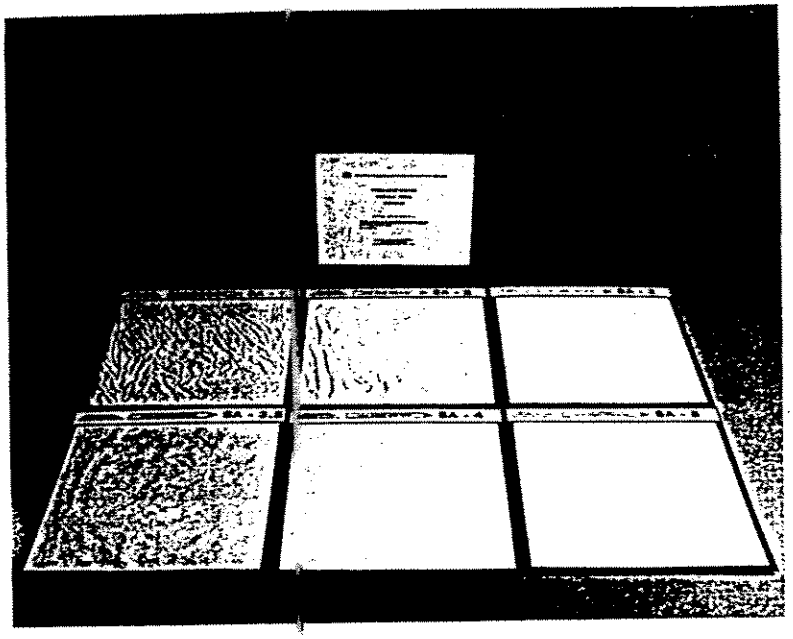

Fig. 2. AATCC 3-D smoothness appearance replicas.

from the side walls near the viewing board can interfere with the rating results. It is recommended that the side walls be painted matte black (85° gloss less than 5 units) or that blackout curtains be mounted on both sides of the viewing board to eliminate the reflective interference.

6.8 Standard AATCC Three-Dimensional Smoothness Appearance Replicas, set of six (see Fig. 2 and 12.2).

6.9 Steam or dry iron with appropriate fabric temperature settings.

6.10 Detergent (for hand wash).

6.11 Scale with at least 5.0 kg or 10.0 lb capacity.

7. Test Specimens

7.1 Three representative 38.0 × 38.0 cm (15.0 × 15.0 in.) fabric specimens cut parallel to the fabric length and width are prepared. Where possible, each specimen should contain different groups of lengthwise and widthwise yarns. The specimens should be marked to indicate the lengthwise direction. If fraying is expected in laundering, see 12.5.

8. Procedure

8.1 Tables II, III and IV summarize the alternate washing and drying conditions and settings. Additional information on the machine and laundering conditions may be found in the monograph, *Standardization of Home Laundry Test Conditions*, elsewhere in this TECHNICAL MANUAL.

8.1.1 It is recognized that special cycles or features are available on current washing machines and dryers to achieve improved performance on certain items; i.e., gentle cycles with reduced agitation to protect delicately constructed items, and durable press cycles, with cool-down or cold rinses and reduced spin speeds, to minimize wrinkling. In evaluating appearance retention, however, the more severe Normal or Cotton Sturdy machine cycle is considered most appropriate. If modifications to any of the cycles (see 8.2) are used, these must be reported in the results (see Section 10).

8.2 Standard washing.

8.2.1 Hand Wash—(see 12.6). Dissolve 20.0 ± 0.1 g of 1993 AATCC Standard Reference Detergent in 7.57 ± 0.06 L (2.00 ± 0.02 gal) of water at 41 ± 3C (105 ± 5F) in a 9.5 L (10.0 qt) pail and then add the three fabric test specimens. Wash for 2.0 ± 0.1 min with no twisting or wringing. Rinse once using 7.57 ± 0.06 L (2.00 ± 0.02 gal) of water at 41 ± 3C (105 ± 5F). Remove the specimens and dry by Procedure C, Drip (see 8.3.3).

8.2.2 Machine Wash—Use specified water level, the selected water temperature for the washing cycle and a rinse temperature of less than 29C (85F). If this rinse temperature is not attainable, record available rinse temperature.

8.2.3 Add 66 ± 0.1 g of 1993 AATCC Standard Reference Detergent. In soft water areas this may be reduced to avoid excessive sudsing, but in that case the amount should be stated in the report of test results.

8.2.4 Add test specimens and enough ballast to make a 1.8 ± 0.06 kg (4.00 ± 0.13 lb) load. Set the washer for the selected washing cycle and time (see Tables II and III). Normal or Cotton Sturdy is recommended. For very critical evaluations and in arbitration, limit the number of specimens per washer load to those from one sample.

8.2.5 For specimens to be dried by Procedures A, B or D, allow washing to proceed automatically through the final spin cycle. Remove the test specimens *immediately* after the final spin cycle, separate tangled pieces, taking care to minimize distortion, and dry by Procedure A, B or D (see Tables II and IV).

Table I. Wash Load Ballast: Finished Fabric Specification

	Wash Load Ballast Type 1	Wash Load Ballast Type 2	Wash Load Ballast Type 3
Fiber Content	**100% Cotton**	**50/50 ± 3% poly/cotton**	**50/50 ± 3% poly/cotton**
Yarns	16/1 ring spun	16/1 ring spun	30/2 ring spun
Fabric Construction	52 (± 2) X 48 (± 2)	52 (± 2) X 48 (± 2)	48 (± 2) X 48 (± 2)
Fabric Weight	155 ± 5 g/m^2 (4.55 ± 0.15 oz/yd^2)	155 ± 5 g/m^2 (4.55 ± 0.15 oz/yd^2)	155 ± 5 g/m^2 (4.55 ± 0.15 oz/yd^2)
Piece Size	92.0 X 92.0 cm (36.0 X 36.0 in.)	92.0 X 92.0 cm (36.0 X 36.0 in.)	92.0 X 92.0 cm (36.0 X 36.0 in.)
Piece Weight	130 ± 10 g	130 ± 10 g	130 ± 10 g

Table II. Alternative Washing and Drying Conditions (see 8.1)

Machine Cycle	Wash Temperatures	Drying Procedures
Hand, in pail	(III) 41 ± 3 C (105 ± 5F)	(A) Tumble:
(1) Normal/ Cotton Sturdy	(IV) 49 ± 3 C (120 ± 5F)	i. Cotton Sturdy
	(V) 60 ± 3 C (140 ± 5F)	ii. Delicate
(2) Delicate		iii. Permanent Press
(3) Permanent Press		(B) Line
		(C) Drip
		(D) Screen

Table III. Washing Machine Conditions (see 8.1)

	Normal/Cotton Sturdy	Delicate	Permanent Press
Water Level	18 ± 1 gal	18 ± 1 gal	18 ± 1 gal
Agitator Speed	179 ± 2 spm	119 ± 2 spm	179 ± 2 spm
Washing Time	12 min	8 min	10 min
Spin Speed	645 ± 15 rpm	430 ± 15 rpm	430 ± 15 rpm
Final Spin Cycle	6 min	4 min	4 min

Table IV. Dr er Conditions (see 8.1)

	Cotton Sturdy	Delicate	Durable Press
Exhaust Temperature	High 66 ± 5C (150 ± 10F)	Low < 60C (140F)	High 66 ± 5C (150 ± 10F)
Cool Down Time	5 min	5 min	10 min

Table V. Fabric Smoothne:s Grades by SA Replica Equivalents

Grade	Description
SA-5	Equivalent to the SA-5 Replic:. Very smooth, pressed, finished appearance.
SA-4	Equivalent to the SA-4 Replic:. Smooth, finished appearance.
SA-3.5	Equivalent to the SA-3.5 Replica. Fairly smooth but nonpressed appearance.
SA-3	Equivalent to the SA-3 Replic:. Mussed, nonpressed appearance.
SA-2	Equivalent to the SA-2 Replic:. Rumpled, obviously wrinkled appearance.
SA-1	Equivalent to the SA-1 Replic:. Crumpled, creased and severely wrinkled appearance.

8.2.6 For specimens to be dried by Procedure C, Drip Dry, remove he specimens from the washer just before the water begins to drain for the final rinse cycle. Remove specimens soaking wet.

8.2.7 Washer creases. Specimens may be in a folded or creased conformation after removal from the washer. Such creases present after laundering should be straightened out prior to drying.

8.3 Drying.

8.3.1 (A) Tumble Dry. Place he washed load (test specimens and ballast) in the tumble dryer and set the temperature control to generate the correct exhaust temperatures as specified in Table IV. For fibers that are heat sensitive, lower temperatures consistent with producers' recommendations are required, and must be reported. Operate he dryer until the total load is dry. Remove the load immediately after the machine stops. Avoid overdrying. Static cling becomes a problem with overdrying, particularly with lightweight fabrics, because it prevents the specimens from tumbling freely.

8.3.2 (B) Line Dry. Hang each fabric specimen by two corners with the fabric length in the vertical direction. Allow specimens to hang in still air at room temperature until dry.

8.3.3 (C) Drip Dry. Hang each dripping wet fabric specimen by two corners with the fabric length in the vertical direction. Allow specimens to hang in still air at room temperature until dry.

8.3.4 (D) Screen Dry. Spread each specimen on a horizontal screen or perforated surface, removing wrinkles but not distorting or stretching the specimen. Allow the specimen to dry in still air at room temperature.

8.3.5 Dryer creases. If specimens are folded or creased after any drying cycle but the last, they should be rewet and an attempt should be made to remove he creases prior to additional washing and drying. No attempt to remove wrinkles or creases should be made after the fifth cycle of drying.

8.4 Repeat the selected washing and drying cycles four more times or to an agreed number of cycles.

8.5 Prior to evaluation, precondition and then condition test specimens as directed in ASTM D 1776, Conditioning Textiles for Testing (see 12.7). Condition the test specimens for a minimum of four hours in the standard atmosphere for textile testing [21 ± 1C (70 ± 2F) and 65 ± 2% RH], hanging each specimen from two corners with the fabric length in vertical direction to avoid distortion.

9. Evaluation

9.1 Three trained observers should rate each test specimen independently.

9.2 The overhead fluorescent light should be the only light source for the viewing board. All other lights in the room should be turned off.

9.3 The observer is to stand directly in front of the specimen 120.0 ± 3.0 cm (4.0 ft ± 1.0 in.) away from the board. It has been found that normal variations in the height of the observer above and below the arbitrary 1.5 m (5.0 ft) eye level have no significant effect on the grade given.

9.4 Mount the test specimen on the viewing board as illustrated in Fig. 1, with the fabric length in the vertical direction. Place the most similar three-dimensional plastic replicas on each side of the test specimen to facilitate comparative rating.

9.5 Although the 3-D Smoothness Appearance (SA) replicas were cast from woven fabrics, it is understood that these wrinkled surfaces do not duplicate all possibilities of fabric surfaces. The replicas are to be used as guides which represent various levels of fabric smoothness or freedom from wrinkles. The observer should mentally integrate degree and frequency of wrinkles in the specimen to determine a level of smoothness that can be identified with the SA replica number which most nearly represents that smoothness appearance level; see Table V.

9.6 Assign the numerical grade of the replica which most nearly matches the smoothness appearance of the test specimen, or assign a grade midway between those whole-number standards which have no half-number standards separating them (SA-1.5, SA-2.5, SA-4.5) if the appearance of the test specimen warrants it.

9.7 An SA-5 grade is equivalent to the SA-5 replica and represents the smoothest appearance, while an SA-1 replica represents very poor appearance.

9.8 If dryer creases are present on any specimens to be evaluated, take care in rating the specimens. Some dryer creases can be disregarded (commonly called "reading out"). When the grade of a dryer creased specimen differs from the other specimens by more than one grade, the test should be repeated with new specimens, taking all precautions to avoid the occurrence of dryer creases.

10. Report

10.1 Average the nine observations made on each test fabric (three grades on each of three test specimens). Report the average to the nearest tenth of a grade. This average is the unit of measure of this test method.

10.2 State washing procedure (Arabic number and Roman numeral) and drying procedure (capital letter and subscript) from Table II, as well as type of wash load ballast (Arabic number). Any deviations from stated procedures, such as use of a modified wash cycle, a reduced amount of detergent or a higher than usual load limit, should be explained completely.

10.2.1 For example, smoothness appearance grade SA-3.8 (1-IV-A(a)-2) denotes a smoothness appearance grade of 3.8 for specimens washed using a Normal (Cotton Sturdy) cycle at 49C (120F) with Wash load ballast type 2 and tumble dried using the Normal (Cotton Sturdy) cycle.

11. Precision and Bias

11.1 *Interlaboratory tests*—Tests were conducted in 1980 with eight laboratories evaluating four fabrics under washing and drying conditions 1-III-A and 1-IV-A of AATCC Method 124. The analysis of variance technique was judged not to be applicable to this data set because its distribution was not normal, and because of the limited and discontinuous scale of replica grades. The data were analyzed by calculating expected laboratory test results from the distribution of individual specimen grades. This analysis has been deposited for reference in the RA61 committee files.

11.2 *Observer repeatability*—From the data it was determined that single observers rated three specimens on the following frequency:

3 specimens to same replica	0.55
2 specimens to same replica and one different	0.40
3 specimens different	0.05

Only rarely did the separation in specimen grades exceed the next replica step. This is indicative of the high degree of repeatability in observer rating of smoothness appearance.

11.3 *Laboratory test result distribution (Within-laboratory repeatability)*—From the observed grade distribution a distribution of laboratory test results was calculated for each replica level with half grades included. Precision over the whole SA replica range was improved.

11.4 *Precision*—From the frequency distribution of laboratory test results, a calculation was made of the critical difference, D, between two laboratory test results. With laboratories at the same level:

Critical Difference	Confidence Level
$D > 0.17$	$P \geq 0.95$
$D \geq 0.25$	$P \geq 0.99$

When two or more laboratories wish to compare test results, it is recommended that laboratory level be established between them prior to commencing test comparisons. Fabrics of known history and performance may be used for this purpose.

Differences between laboratory test results (on the same fabric, under the same washing and drying conditions) equal to or greater than a quarter replica unit are statistically significant at $P \geq 0.99$. A difference of this magnitude or greater suggests a difference in laboratory levels and indicates the need for laboratory level comparisons.

11.5 *Bias*—The true value of smoothness appearance in durable press fabrics after repeated home launderings can be defined only in terms of a test method. There is no independent method for determining the true value. As an estimate of this property, this test method has no known bias.

12. Notes

12.1 Contact AATCC, P.O. Box 12215, Research Triangle Park NC 27709; tel: 919/549-8141; fax: 919/549-8933, for model number(s) and source(s) of approved washer(s) and dryer(s). Any other washer or dryer which is known to give comparable results can be used. Washing machine conditions given in Table III represent the actual speeds and times available on the current specified model(s). Other washers can vary in one or more of these settings. Dryer machine conditions given in Table IV represent the actual temperatures and cool-down times available on the current specified model(s). Other dryers can vary in one or more of these settings.

12.2 Available from AATCC, P.O. Box 12215, Research Triangle Park NC 27709; tel: 919/549-8141; fax: 919/549-8933. For further information on detergent selection see the monograph, *AATCC Standard Reference Detergent 124 and Laundry Detergents in General*, elsewhere in this TECHNICAL MANUAL.

12.3 Ballast are available from Testfabrics Inc., P.O. Box 420, Middlesex NJ 08846; tel: 908/469-6446; fax: 908/469-1147; and Textile Innovators Corp., P.O. Box 8, Windsor NC 27983; tel: 919/794-9703; fax: 919/794-9704. Ballast fabrics should conform to specifications in Table I.

12.4 The use of 8-foot fixtures for viewing laundered specimens is specified in this method. It is recognized, however, that physical limitations in certain laboratories will prevent the use of 8-foot fixtures. In those situations, 4-foot lights may be used but replicas identified as SA-4, SA-3 and SA-1 should always be placed on the left side of the viewing board as the board is viewed from the front. Replicas identified as SA-5, SA-3.5 and SA-2 should always be placed on the viewing board to the right side as the board is viewed from the front.

12.5 If excessive fraying occurs in laundering, specimen edges should be pinked, slashed or stitched as appropriate. If edges of laundered specimens appear distorted, clip as necessary before evaluating.

12.6 Like other hand wash procedures, this procedure has inherent limitations; e.g., limited reproducibility of the type of action involved due to the human element.

12.7 ASTM standards are available from ASTM, 100 Barr Harbor Dr., West Conshohocken PA 19428; tel: 610/832-9500; fax: 610/832-9555.

12.8 The AATCC Technical Center conducted a study to compare the 1993 AATCC Standard Reference Detergent, AATCC Standard Reference Detergent 124 and two different types of fabrics (current and proposed) to be used as ballast, under the following test conditions:

Machine cycle:	(I)—Normal/Cotton Sturdy
Washing Temp:	(V)—60 ± 3C (140 ± 5F)
Drying Procedure:	(A)i—Tumble dry, cotton sturdy cycle
Fabrics tested:	White Twill (100% cotton) Beige Twill (100% cotton) Grey Poplin (100% cotton) Blue Twill (50/50 poly/cotton)

No significant differences were found in the results using either detergent or ballast load fabrics.

Tab B

United States
CONSUMER PRODUCT SAFETY COMMISSION
Washington, D.C. 20207

MEMORANDUM

DATE: February 19, 1997

TO : Margaret L. Neily, ES
Project Manager, Wearing Apparel

Through: Warren J. Prunella, Associate Executive Director
for Economic Analysis

FROM : Terrance R. Karels, EC

SUBJECT: FR-treated Cotton Children's Sleepwear

This is in response to your request of February 7, 1997, asking that we provide an estimate of the share of the children's sleepwear market accounted for by cotton sleepwear which has been treated with a flame retardant (FR) chemical.

We have contacted four industry sources, each of whom indicated that such garments represent an insignificant share of the overall children's sleepwear market:

- Allison Wolf, a spokesperson for the American Apparel Manufacturers Association (AAMA), reported that there has been some discussion (by manufacturers) of the potential market for such garments, but that the current share was "nil." The AAMA was not aware of any apparel manufacturer currently marketing such a product.

- Kay Villa, Assistant Director of the American Textile Manufacturers Institute stated that the largest domestic supplier of FR fabric is Western Westex, and that firm would be aware of the overall demand for such fabric treatments.

- William Baitinger of Westex reported that the demand for FR-treated fabric for children's sleepwear is "practically nothing," and "certainly less that one percent" of the total market.

- Dr. John Michener of the Milliken Research Corporation described the demand for FR-treated cotton fabric for children's sleepwear as "nothing, less than one percent of the total."

United States
CONSUMER PRODUCT SAFETY COMMISSION
Washington D.C. 20207

MEMORANDUM

DATE: August 10, 1998

TO : Margaret L. Neily, ESME
Project Manager, Wearing Apparel

Through: Warren J. Prunella, Associate Executive Director
for Economic Analysis WJP

FROM : Terrance R. Karels, Economic Analysis TRK

SUBJECT: Amendments to FFA Standards

The Commission is considering amendments to the standards issued under the Flammable Fabrics Act (FFA) for children's sleepwear, carpets and rugs, and mattresses and mattress pads (CFR 1615,1616,1630,1631, and 1632). The proposed amendments would address the laundering requirements for fabrics that use flame retardant chemicals in order to comply with the regulations. Repeated launderings are used to determine whether the fabrics would maintain their flame resistance in normal use.

The amendments are not expected to have any effect on manufacturers, consumers or other parties. This is because the proposed changes are intended to bring standards promulgated in the 1970s into conformance with current practices. Independent testing laboratories report that they currently use the requirements of the proposed amendments.

Detergents

The proposal would modify the specified "standard reference" laundry detergent used to measure test fabric compliance to the flammability standards. The original testing requirements specified the use of a reference detergent containing phosphates. The sale of detergents containing phosphates is banned by many state and local ordinances to reduce water pollution. In 1993, the American Association of Textile Chemists and Colorists (AATCC, a technical, scientific, and educational organization for the textile industry) developed a new non-phosphate "standard reference" detergent. Independent testing laboratories report that it is current industry practice to test with this new non-phosphate detergent. In fact, the AATCC reports that its stock of the old reference detergent is depleted; thus, it is nearly impossible for manufacturers and others to test to the existing standards under the FFA.

Since the amendments regarding the type of detergents reflect that which is now being used in compliance testing, there would be no effect to the detergent itself or to the fabrics being tested. The modification of the detergent formulation is not expected to result in either costs or benefits to society; however, it would update the standard to reflect the type of detergent currently available to consumers.

Laundry Equipment

The amendments also propose changes in the rinse water temperature, agitator and spin speed, and the duration of spin. These changes reflect changes in home laundering equipment over the years. The standard home laundering equipment reflected in the standards is no longer manufactured.

The laundering methods referenced in the FFA standards were earlier versions of AATCC Test Method 124. The proposed amendments regarding laundry equipment are identical to those specified in AATCC Test Method 124-96, the most recently updated version.

The proposed amendments regarding water temperature, speeds, and duration of cycles are identical to those to which fabrics are currently tested. Thus, there would be no effect on the types of equipment needed or fabrics tested. These proposals are not expected to result in any costs or benefits to society, but would result in tests which more closely resemble consumer use.

Small Entities

The Regulatory Flexibility Act (RFA) requires that the Commission consider whether a proposed rule would have a significant effect on a substantial number of small entities, including small businesses. However, since the proposals merely codify existing industry testing practices, the proposed amendments are expected to have no effect on small entities.

Consequently, staff estimates that the proposed amendments will have no economic consequences to any manufacturer, or other entity, large or small.

Environmental Impact

The National Environmental Policy Act requires that the Commission consider the potential impact to the environment as a result of a proposed rule. Since this proposal continues current industry practices without any additional requirements, the proposed rule would have no significant impact on the environment. The amendments are not expected to have a significant effect on production processes or on the types or amounts of materials used in production or packaging. It will not render existing inventories unsalable or require destruction of existing products.